A new subfamily of fossorial colubroid snakes from the Western Ghats of peninsular India

V. Deepak[a,b*], Sara Ruane[c], David J. Gower[a]

[a]*Department of Life Sciences, The Natural History Museum, London SW7 5BD, UK*; [b]*Centre for Ecological Sciences, Indian Institute of Science, Bangalore, 560012, India*; [c]*Department of Biological Sciences, Rutgers University-Newark, 195 University Ave, Newark, New Jersey, 07102, USA*; [*]*Corresponding author*

[a]*Department of Life Sciences, The Natural History Museum, London SW7 5BD, UK.*

E-mail: veerappandeepak@gmail.com

A new subfamily of fossorial colubroid snakes from the Western Ghats of peninsular India

Abstract

We report molecular phylogenetic and dating analyses of snakes that include new mitochondrial and nuclear DNA sequence data for three species of the peninsular Indian endemic *Xylophis*. The results provide the first molecular genetic test of and support for the monophyly of *Xylophis*. Our phylogenetic results support the findings of a previous, taxonomically restricted phylogenomic analysis of ultraconserved nuclear sequences in recovering the fossorial *Xylophis* as the sister taxon of a clade comprising all three recognised extant genera of the molluscivoran and typically arboreal pareids. The split between *Xylophis* and 'pareids' is estimated to have occurred on a similar timescale to that between most (sub)families of extant snakes. Based on phylogenetic relationships, depth of molecular genetic and estimated temporal divergence, and on the external morphological and ecological distinctiveness of the two lineages, we classify *Xylophis* in a newly erected subfamily (Xylophiinae subfam. nov.) within Pareidae.

Key words

Asia, classification, Pareidae, Pareinae, phylogenetics, *Xylophis,* taxonomy

Introduction

The caenophidian snake genus *Xylophis* Beddome, 1878 contains three currently recognised species of small fossorial snakes endemic to the southern part of the

Western Ghats of peninsular India (Gower and Winkler 2007, Wallach et al. 2014; Srinivasulu et al. 2014). Morphological systematists have not settled on the phylogenetic relationships of *Xylophis* or of its corresponding suprageneric classification. For example, Underwood (1967) included *Xylophis* in his concept of Dipsadidae, a group comprising xenodermines, pareines, calamarines, sibynophiines, lycodontines, xenodontines and some then enigmatic Asian natricines (including the Sri Lankan *Aspidura*—to which at least superficial similarities to *Xylophis* were noted by Gans and Fetcho 1982, Dowling and Pinou 2003, Gower and Winkler 2007, and Simões et al. 2016). Since Underwood's (1967) work, *Xylophis* has been considered to be a xenodermid (or xenodermatid/xenodematine/xenodermine depending on authority) (McDowell 1987, 2008, Wallach 1998, Zaher 1999, Vidal 2002, Lawson et al. 2005, Cundall and Irish 2008: 556, 573, Zaher et al. 2009, Pyron et al. 2013, Dowling and Pinou 2003, see also Underwood 1967: 98), an elapoid *incertae sedis* (Wallach et al. 2014), and a colubrine (Cundall and Irish 2008: 645).

Until recently, there were no molecular systematic data available for *Xylophis*. Simões et al. (2016) published sequences of three visual opsin genes for *X. captaini*. Although noted as not being neutral phylogenetic markers, Simões et al. (2016) reported various phylogenetic results for *X. captaini* for each of these three genes in isolation: for locus *rh1, X. captaini* was recovered as sister to the pareid *Pareas monticola,* with this clade being sister to all other sampled non-viperid colubroids; for locus *sws1, X. captaini*, was recovered as sister to all other sampled colubroids (*P. monticola* was not sampled for this gene); for locus *lws, X. captaini* was recovered as sister to *Amphiesma stolata* within natricine colubrids (again, *P. monticola* was not sampled for this gene). Although the sister relationships with *P. monticola* (for *rh1*) and with *A. stolata* (for *lws*) were well supported, most of the deeper internal branches throughout these trees were not well-resolved.

Ruane and Austin (2017) sampled one historical museum specimen of *Xylophis stenorhynchus* in an application of ultraconserved element loci in snake phylogenomics, combining their historical sampling with modern snake sample data from Streicher and Wiens (2016). Ruane and Austin's sampling was sparse (17 species of caenophidians, including one xenodermid and no natricines) but *X. stenorhynchus* was recovered as the well-supported sister taxon to the single sampled pareid, *Pareas hamptoni,* and the number of ultraconserved elements generated for *X. stenorhynchus* (2546 loci) was on par with modern samples (see Table 1, Ruane and Austin 2017). As currently conceived, pareids comprise ca. 20 nocturnal, molluscivorous, non-fossorial species (classified in three genera: *Pareas* Wagler, 1830; *Aplopeltura* Duméril, 1853; *Asthenodipsas* Peters, 1864) restricted to east and Southeast Asia, with two species (*P. monticola* (Cantor, 1839) and *P. margaritophorus* (Jan, 1866)) extending into northeast India (Whitaker and Captain 2004, Uetz et al. 2017). Commenting on their somewhat unexpected phylogenetic result for *Xylophis*, Ruane and Austin (2017: 5) suggested that the phylogenetic relationships of this genus could be investigated more thoroughly by analysing a wider sample of snakes, including more species of *Xylophis*.

Here we report sequence data for 'standard' mitochondrial (mt) and nuclear (nu) phylogenetic markers for snakes for three species of *Xylophis* and include them in broadly taxonomically sampled phylogenetic analyses of extant snakes. These analyses provide the first molecular test of the monophyly of the genus, and the results support classification of *Xylophis* in a newly erected subfamily within Pareidae.

Material and methods

Classification and institutional abbreviations

We followed the family and subfamily classification used by Uetz et al. (2018), including the recently described subfamilies Ahaetuliinae Figueroa et al. 2016 (within Colubridae) and Cyclocorinae Weinell and Brown, 2018 (within Lamprophiidae). *Xylophis* tissues were sampled from vouchers deposited in the Bombay Natural History Society, Mumbai, India (BNHS), California Academy of Sciences, San Francisco, USA (CAS), and Centre for Ecological Sciences, IISc, Bengaluru, India (CES).

Molecular data and phylogenetic analysis

We generated DNA sequence data for two specimens from freshly collected tissue, a *Xylophis perroteti* from the Nilgiris (CESG 2016b) and a *X. captaini* from the type locality Kannam, Kottayam District (BNHS 3376). Genomic DNA was extracted from liver tissue samples stored in absolute ethanol at –20°C. DNeasy (Qiagen™) blood and tissue kits were used to extract DNA. We amplified partial sequences of three mitochondrial (mt) genes and three nuclear (nu) genes. The mt genes are 16S rRNA (*16s*), cytochrome b (*cytb*) and NADH dehydrogenase subunit 4 (*nd4*), and the nu markers are the recombination activating gene 1 (*rag1*), oocyte maturation factor (*cmos*), and brain-derived neurotrophic factor (*bdnf*). DNA PCR amplification and Sanger sequencing used previously reported primers (Palumbi et al. 1991; Arévalo et al. 1994; Palumbi 1996; Parkinson et al. 2000; Noonan and Chippindale, 2006; Wiens et al. 2008).

We attempted to extract homologous sequences for our phylogenetic markers from the unfiltered, unassembled, raw sequence reads that were generated during targeted sequencing of ultra-conserved elements (UCEs) for a historical specimen (CAS 17199) of *Xylophis stenorhynchus* from Ruane and Austin (2017). These data comprised 32,236,948 reads each for read 1 and read 2. Although none of the loci used in this study was targeted by the UCE probe kit (MYbaits tetrapod 5K kit, which targets 5060 UCEs from amniotes: Faircloth et al. 2012) used by Ruane and Austin (2017), we considered it possible that the loci of interest were sequenced as "bycatch" during the high-throughput sequencing, particularly for mtDNA genes due to the high number of copies of these loci in genomic DNA.

Using the program Geneious (Kearse et al. 2012) Ruane and Austin's (2017) unfiltered reads for *X. stenorhynchus* were mapped to each of the newly generated *X. captaini* and *X. perroteti* Sanger sequences for *16s*, *cytb*, *nd4*, *cmos*, *rag1,* and *bdnf* (see Table 1). This was done using the Geneious align/assemble option "map to reference", with the modern sample serving as the reference for the unfiltered *X. stenorhynchus* reads; sensitivity was set to medium-low with up to five iterations. Where successful, the resulting mapped reads of *X. stenorhynchus* were combined into consensus sequences for each marker to be included in subsequent analyses.

We constructed a molecular dataset for 507 leaves (500 snakes + 7 non-snake squamates; 493 + 7 species, respectively) including 14 of the 20 currently recognised species of pareids. Data coverage for each of the genes in the dataset are as follows: *cytb* 80.9%, *16s* 68.1%, *nd4* 58.8 %, *cmos* 71.6 %, *bdnf* 30.4% and *rag1* 13.6%. GenBank accession numbers for all sequences included in our phylogenetic and dating analyses are presented in Table S1. Alignments per gene were carried out in MEGA 5 (Tamura et al. 2011) using the ClustalW algorithm with default parameters and are available online from the Natural History Museum data portal (http://data.nhm.ac.uk/ dataset/deepak-xylophis). Uncorrected p-distances and Kimura

2-parameter (Kimura, 1980) distances were calculated using MEGA 5. Phylogenetic analysis was implemented in the program RAxML v7.4.2 GUI (Stamatakis, 2006; Silvestro and Michalak 2012) with the six gene concatenated dataset. This dataset was 4,557bp long and was partitioned by gene and by codon, a total of 11 partitions (see Table S2), determined as the best-fit scheme using ParitionFinder 1.2 (Lanfear et al. 2012). We used GTRGAMMA model in RAxML which is recommended over the GTR +G+ I because the 25 rate categories account for potentially invariant sites (Stamatakis, 2006), as was also implemented in other large-scale snake molecular phylogenetic analyses (Pyron et al. 2011; Zaher et al. 2012; Figueroa et al. 2016).

Divergence times were estimated using a subset of taxa for the same genes, with a dataset containing 81 snake species including representatives of all extant subfamilies of alethinophidian snakes and all extant families of scolecophidians (Table 1). These data were newly aligned (using the methods outlined above, alignment available at: http://data.nhm.ac.uk/ dataset/deepak-xylophis), producing a dataset 4,504bp. PartitionFinder 1.2 (Lanfear et al. 2012) was used to identify the best-fitting partition scheme and model(s) of sequence evolution according to the Bayesian Information Criterion (BIC) using the default greedy algorithm with linked branch lengths (see Table S3 for partitions and models). We explored the sensitivity of our phylogenetic results to our selected (ClustalW) alignment method by alternatively aligning the *16s* data also with MUSCLE (Edgar, 2004), as well as using Gblocks v0.91b (Castresana, 2000) to identify and remove ambiguously aligned sites from the ClustalW alignment using the ‘less stringent’ option. These alternative approaches to the *16s* data did not notably change the topology or support values in optimal RAxML (data partitioned by gene and by codon) trees for the concatenated data (Fig. S1).

Divergence times were estimated using a Bayesian relaxed uncorrelated lognormal clock model implemented in BEAST 1.8.2 (Drummond et al. 2012). We used fossil calibrations recommended by Head (2015) and Head et al. (2016) to date minimum ages of five divergences: (1) oldest divergence within crown Alethinophidia based on *Haasiophis terrasanctus* Tchernov et al. 2000; minimum age 93.9 Ma, soft maximum 100.5 Ma, (2) oldest divergence between non-xenodermid colubroids and their closest living relative (Xenodermidae in our tree), based on *Procerophis sahnii* Rage et al. 2008; minimum 50.5 Ma, soft maximum 72.1 Ma, (3) divergence between Boinae and its sister taxon (Erycinae + Candoiinae in our tree) based on *Titanoboa cerrejonensis* Head et al. 2009; minimum 58 Ma, soft maximum 64 Ma, and (4) divergence between Viperinae and Crotalinae based on *Vipera aspis* complex (Szyndlar and Rage 1999); minimum 20.0 Ma, soft maximum 23.8 Ma, and (5) oldest divergence within elapids based on *Naja romani* (Hoffstetter, 1939); minimum age 17 Ma, soft maximum 60 Ma (see Table S4 for exact values applied to each calibration prior). Analyses used random starting trees, with clock and tree models linked across partitions. Two independent analyses were run for 600,000,000 generations sampling every 5000 trees, the effective sample size (ESS) values were evaluated using Tracer 1.6 (Rambaut et al. 2014). The prior distribution for all fossil calibrations was set to lognormal.

Results

Phylogenetic inference

Mapping the Sanger sequencing data for *Xylophis captaini* and *X. perroteti* against the unfiltered *X. stenorhynchus* high-throughput sequence reads resulted in potentially homologous consensus sequences for the latter for *16s* (441bp; 103 reads assembled), *cytb* (513bp; 60 reads), *nd4* (328bp; 61 reads), *cmos* (169bp; 6 reads), and bdnf (91bp; 4 reads). These consensus sequences are reported in Table 1. These sequences were similar to those of *X. perroteti* (uncorrected p-distances 0.078 for *16s*; 0.204 for *nd4*; 0.037 for *cmos*; 0.045 for *bdnf*) and *X. captaini* (uncorrected p-distances 0.114 for *16s*; 0.221 for *cytb*).

Our ML phylogenetic analysis provides strong support for the monophyly of *Xylophis* and for the sister group relationship between *Xylophis* and a clade comprising the pareids *Pareas*, *Aplopeltura* and *Asthenodipsas* (Figs. 1 and S2). Within the latter clade, *Pareas* and *Asthenodipsas* are strongly supported as monophyletic, with the former being sister to the monotypic *Aplopeltura*. The *Xylophis, Pareas*, *Aplopeltura* and *Asthenodipsas* clade (here considered to comprise Pareidae) is recovered as a member of a lineage comprising all colubroids except Xenodermidae. Although there is strong signal for pareids lying outside a group comprising most other colubroids, the relationships among Pareidae, Viperidae and all other non-xenodermid colubroids are not clearly resolved by our analyses. Uncorrected p-distances between *Xylophis* and the other three pareid genera for the sampled genes are 0.07–0.12 (*16s*), 0.27–0.38 (*cytb*), 0.21–0.25 (*nd4*), 0.03–0.1 (*cmos*) and 0.03 (*bdnf*). Pairwise distances between recognised colubroid families and between intrafamilial subfamilies for *cmos* and *bdnf* (reported in Tables S5–S8) are summarised in Fig. 2. The molecular dating analysis recovers an estimated minimum divergence of 55–35 Ma between *Xylophis* and its sister taxon (*Pareas*, *Aplopeltura* and *Asthenodipsas*) (Fig. 3). Rerunning the dating analysis but excluding third codon positions of the mitochondrial genes *cytb* and *nd4* did not notably alter the results for most divergences (including that for *Xylophis* versus its sister) in terms of relative ages (Fig. S3), with estimated divergence dates for the two analytical treatments being strongly correlated (Fig. S4).

Systematics

Based on the well-supported inferred phylogenetic relationships of *Xylophis* and divergence from its extant sister lineage, we refer the genus to the family Pareidae, and re-define the latter phylogenetically as all snakes more closely related to *Pareas carinatus* Wagler, 1830 than to *Xenodermus javanicus* Rheinhardt, 1836, *Vipera aspis* (Linnaeus, 1758) or *Homalopsis buccatus* (Linnaeus, 1758). Given the molecular genetic and phenotypic distinctiveness of the two lineages comprising the basal split within Pareidae, we classify *Pareas*, *Aplopeltura* and *Asthenodipsas* within the subfamily Pareinae (defined phylogenetically as all snakes more closely related to *Pareas carinatus* Wagler, 1830 than to *Xylophis perroteti* Duméril, Bibron and Duméril, 1854) and we erect a new subfamily for *Xylophis*:

DIAPSIDA Osborn, 1903

Superorder **LEPIDOSAURIA** Haeckel, 1866

Order **SQUAMATA** Oppel, 1811

Suborder **SERPENTES** Linnaeus, 1758

Infraorder **CAENOPHIDIA** Hoffstetter, 1939

Superfamily **COLUBROIDEA** Oppel, 1811

Family **PAREIDAE** Romer, 1956

Subfamily **Xylophiinae** subfam. nov.

Type genus

Xylophis Beddome, 1878

Content

A single genus with three currently recognised species: *X. stenorhynchus* (Günther, 1875); *X. perroteti* Duméril, Bibron and Duméril, 1854; *X. captaini* Gower and Winkler, 2007. *Xylophis indicus* Beddome, 1878 has been considered a synonym of *X. stenorhynchus* (e.g., Smith 1943, Wallach et al. 2014) but might also be valid (Gower and Winkler 2007). *Xylophis perroteti* includes the synonyms *Rhadosoma microcephalum* Günther, 1858 (e.g., Smith 1943, Wallach et al. 2014).

Phylogenetic definition

All snakes more closely related to *Xylophis perroteti* than to *Pareas carinatus* Wagler, 1830.

Diagnosis

Colubroid snakes with first (anteriormost) three pairs of infralabial shields reduced to narrow strips, together much smaller than large pair of anterior chin (genial) shields.

Distribution

The Western Ghats region of peninsular India. *Xylophis* is thus far known only from the southern part of the Western Ghats, in the states of Kerala and Tamil Nadu (Fig. 4). Species of the genus have been recorded from close to sea level (*Xylophis captaini*: Gower and Winkler 2007) to at least 2,000 m (*X. perroteti*: Srinivasulu et al. 2014).

Discussion

Age of divergence (whether absolute or relative) between sister lineages has sometimes been applied as a secondary criterion in recognition of suprageneric taxa (e.g., Wilkinson et al. 2011), including the formal naming of new families (e.g. Kamei et al. 2012). Although the general application of such a criterion has been cautioned against (e.g., Vences et al. 2013; Frost 2017: see "comments on taxonomy related to version 5.6"), we see some merit in using estimated divergence age cautiously as an additional guide alongside phylogenetic relationships and extent of phenotypic and raw molecular genetic divergence. In this case, we take some comfort in naming a new subfamily given that the estimated age of divergence of Xylophiinae from Pareinae is comparable to that between sister pairs of other snake (sub)families (Figs. 3 and S3).

Although xylophiines and pareines are phenotypically disparate superficially, the anatomy and anatomical diversity of these two lineages (and of other major lineages of colubroids) is insufficiently known to yet rule out the identification of unambiguous synapomorphies for Pareidae. Although classifying *Xylophis* as a xenodermine on the basis of skull, head muscle and hemipenis features, McDowell (1987: 35–36) also drew attention between at least *X. perroteti* and pareines (and calamariines) in terms of posteriorly extensive kidneys and a distinct rectal caecum. The morphology of *Xylophis* is poorly studied and further work in the light of the renewed interest in its phylogenetic relationships seems warranted.

The evolutionary divergence between xylophiines and pareines resulted in sister clades with markedly differing distributions, morphologies and ecologies. Although both lineages comprise small to moderately sized predators of invertebrates, xylophiines are small-headed, small-eyed, fossorial, relative generalist or opportunistic predators (Kumar and Kannan 2017) restricted to the southern part of the Western Ghats of peninsular India, while pareines are relatively larger-headed (head greater in girth than anterior of body), large-eyed, surface dwelling (often arboreal) specialist molluscivores (Cundall and Greene, 2000) restricted almost entirely to east and southeast Asia (also extending into northeast India; Fig. 4). Given that the Indian subcontinent (part of Gondwana) did not accrete with the rest of Asia until ca.55 Ma (Patriat and Achache, 1984), our estimated divergence between xylophiines and pareines (55–35 Ma) is consistent with dispersal of either a peninsular Indian ancestor into east/southeast Asia or *vice versa*. This hypothesis is a little more parsimonious than one invoking a widespread ancestral pareid lineage with followed by spatially exclusive extinctions of xylophiines (in east and southeast Asia) and pareines (in peninsular India). However, that Pareidae, Xenodermidae and Acrochordidae are all Asian and that they might comprise a paraphyletic assemblage lying successively outside of a clade (= Endoglyptodonta of Zaher et al. 2009) comprising Viperidae, Elapidae, Colubridae, and Lamprophiidae (e.g. Vidal et al. 2007, Zaher et al. 2009, Grazziotin et al. 2012, Pyron et al. 2013, Figueroa et al. 2016) is more supportive of an Asian (rather than Gondwanan) origin of Pareidae, and thus of a dispersal of the ancestor of the Xylophiinae lineage into peninsular India from east or southeast Asia rather than *vice versa*. Resolution of the phylogenetic position of the northeast Indian *Pareas moniticola* and *P. margaritophorus* might usefully inform the question of the historical biogeography of Pareidae (or at least of Pareinae).

Geolocation Information

Study Area (box): 8.65000º N, 76.95000 º E to 11.31198 º N, 76.58653 º E

Acknowledgements

In addition to people acknowledged by Gower and Winkler (2007), we thank Srihari Ananthakrishna and Krishna Chaitanya for their support during fieldwork. Chinta Sidharthan is thanked for help with some of the lab work, and Mark Wilkinson and Natalie Cooper for help with some of the analyses. VD thanks Achyuthan Srikanthan for sharing *Xylophis perroteti* photos. We also further thank those acknowledged in Ruane and Austin (2017), especially Jens Vindum (California Academy of Sciences) for the loan of *Xylophis stenorhynchus* and Jeff Streicher for sharing the dataset from Streicher and Wiens (2016). Part of this project was made possible from NSF DEB-1146033 to C.C. Austin. VD's contribution was support, in part, by Marie Skłodowska-Curie Fellowship EU project 751567.

References

Arévalo E, Davis SK, Sites JW. 1994. Mitochondrial DNA sequence divergence and phylogenetic relationships among eight chromosome races of *Sceloporus grammicus* complex (Phrynosomatidae) in Central Mexico. Syst Biol. 43: 387–418.

Castresana J. 2000. Selection of conserved blocks from multiple alignments for their use in phylogenetic analysis. Mol Biol Evol. 17: 540–552.

Cundall D, Irish FJ. 2008. The snake skull. In: Gans C, Gaunt AS, Adler K, editors. Biology of the Reptilia, v.20 (Morphology H: The Skull of Lepidosauria). Ithaca, New York: Society for the Study of Amphibians and Reptiles; p. 349–692.

Cundall D, Greene HW. 2000. Feeding in snakes. In: Schwenk K, editor. Feeding form, function, and evolution in tetrapod vertebrates. San Diego, CA: Academic Press; p. 293–333.

Dowling HG, Pinou T. 2003. Xenodermatid snakes in America. Herpetol Rev. 34: 20–23.

Drummond AJ, Suchard MA, Xie D, Rambaut A. 2012. Bayesian phylogenetics with BEAUti and the BEAST 1.7. Mol Biol Evol. 29: 1969–1973.

Edgar RC. 2004. MUSCLE: multiple sequence alignment with high accuracy and high throughput. Nucleic Acids Res. 32: 1792–1797.

Faircloth BC, McCormack JE, Crawford NG, Harvey MG, Brumfield RT, Glenn TC. 2012. Ultraconserved elements anchor thousands of genetic markers spanning multiple evolutionary timescales. Sys Biol. 61: 717–726.

Figueroa A, McKelvy AD, Grismer LL, Bell CD, Lailvaux SP. 2016. A species-level phylogeny of extant snakes with description of a new colubrid subfamily and genus. PLoS One, 11(9), p.e0161070.

Frost DR. 2017. Amphibian Species of the World: an Online Reference. Version 6.0 (Date of access). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA

Gans C, Fetcho JR. 1982. The Sri Lankan genus *Aspidura* (Serpentes, Reptilia, Colubridae). Carnegie Mus Nat Hist. 51: 271–316.

Gower DJ, Winkler JD. 2007. Taxonomy of the Indian snake *Xylophis* Beddome (Serpentes: Caenophidia), with description of a new species. Hamadryad 31: 315 – 329.

Grazziotin FG, Zaher H, Murphy RW, Scrocchi G, Benavides MA, Zhang YP, Bonatto SL. 2012. Molecular phylogeny of the new world Dipsadidae (Serpentes: Colubroidea): a reappraisal. Cladistics 28: 437–459.

Günther A. 1858. Catalogue of Colubrine snakes of the British Museum. London.

Head JJ, Mahlow K, Müller J. 2016. Fossil calibration dates for molecular phylogenetic analysis of snakes 2: Caenophidia, Colubroidea, Elapoidea, Colubridae. Palaeontol Electron. 19: 1–21.

Head JJ. 2015. Fossil calibration dates for molecular phylogenetic analysis of snakes 1: Serpentes, Alethinophidia, Boidae, Pythonidae. Palaeontol Electron 18: 1–17.

Kamei RG, San Mauro D, Gower DJ, Van Bocxlaer I, Sherratt E, Thomas A, Babu S, Bossuyt F, Wilkinson M, Biju SD. 2012. Discovery of a new family of amphibians from northeast India with ancient links to Africa. Proc R Soc Lond [Biol]. 279: 2396–2401.

Kearse M, Moir R, Wilson A, Stones-Havas S, Cheung M, Sturrock S, Buxton S, Cooper A, Markowitz S, Duran C, Thierer T. 2012. Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. Bioinformatics 28: 1647–1649.

Kimura M. 1980. A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. J Mol Evol 16:111–120.

Kumar PS, Kannan P. 2017. Striped Narrow-headed Snake: Diet of the endemic *Xylophis perroteti* in Nilgiris. Reptile Rap 32: 22–23.

Lanfear R, Calcott B, Ho SYW, Guindon S. 2012. Partitionfinder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. Mol Biol Evol. 29: 1695–1701.

Lawson R, Slowinski JB, Crother BI, Burbrink FT. 2005. Phylogeny of the Colubroidea (Serpentes): new evidence from mitochondrial and nuclear genes. Mol Phylogenet Evol. 37: 581–601.

McDowell SB, 1987. Systematics. In: Seigel RA, Collins JT, Novak SS, editors. Snakes: Ecology and evolutionary biology. New York: Macmillan Publishing; p. 3–50.

Noonan BP, Chippindale PT. 2006. Dispersal and vicariance: the complex evolutionary history of boid snakes. Mol Phylogenet Evol. 40: 347–358.

Palumbi SR, Martin AP, Romano SL, McMillan WO, Stice L, Grabowski G. 1991. The Simple Fool's Guide to PCR ver. 2. University of Hawaii, Honolulu.

Palumbi SR. 1996. The polymerase chain reaction. In: Hillis DM, Moritz C, Mable BK, editors. Molecular systematics. 2nd Edition. Massachusetts: Sinauer Associates; p. 205–247.

Parkinson CL, Zamudio KR, Greene HW. 2000. Phylogeography of the pitviper clade *Agkistrodon*: historical ecology, species status, and conservation of cantils. Mol Ecol. 9: 411–420.

Patriat P, Achache J. 1984. India-Asia collision chronology has implications for crustal shortening and driving mechanism of plates. Nature 311: 615–621.

Pyron RA, Burbrink FT, Wiens JJ. 2013. A phylogeny and revised classification of Squamata, including 4161 species of lizards and snakes. BMC Evol Biol 13: 93.

Pyron RA, Burbrink FT, Colli GR, de Oca ANM, Vitt LJ, Kuczynski CA, Wiens JJ. 2011. The phylogeny of advanced snakes (Colubroidea), with discovery of a new subfamily and comparison of support methods for likelihood trees. Mol Phylogenet Evol. 58: 329–342.

Rambaut A, Suchard MA, Xie D, Drummond AJ. 2014. Tracer v1. 6. Available from http://beast.bio.ed.ac.uk.Tracer (accessed July 27, 2014).

Ruane S, Austin CC. 2017. Phylogenomics using formalin-fixed and 100+ year-old intractable natural history specimens. Mol Ecol Resour. 17: 1003–1008.

Savage JM. 2015. What are the correct family names for the taxa that include the snake genera *Xenodermus*, *Pareas*, and *Calamaria*? Herpetol Rev. 46: 664–665.

Simões BF, Sampaio FL, Douglas RH, Kodandaramaiah U, Casewell NR, Harrison RA, Hart NS, Partridge JC, Hunt DM, Gower DJ. 2016. Visual pigments, ocular filters and the evolution of snake vision. Mol Biol Evol. 33: 2483–2495.

Smith MA. 1943. The fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese sub-region. Reptilia and Amphibia. Volume III. Serpentes. Taylor and Francis, London.

Srinivasulu C, Srinivasulu B, Molur S. 2014. The status and distribution of reptiles in the Western Ghats, India. Conservation Assessment and Management Plan

(CAMP). Wildlife Information Laision Development Society, Coimbatore, Tamil Nadu.

Stamatakis A. 2006. RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22: 2688–2690.

Silvestro D, Michalak I. 2012. RAxML GUI: a graphical front-end for RAxML. Org Divers Evol. 12: 335–337.

Streicher JW, Wiens JJ. 2016. Phylogenomic analyses reveal novel relationships among snake families. Mol Phylogenet Evol. 100: 160–169.

Tamura K, Peterson D, Peterson N, Stecher G, Nei M, Kumar S. 2011. MEGA5: molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. Mol Biol Evol. 28: 2731–2739.

Uetz P, Freed P, Hošek J (Eds.). 2018. The Reptile Database, http://www.reptile-database.org (accessed November 14, 2018).

Underwood G. 1967. A Contribution to the Classification of Snakes. British Museum (Natural History), London.

Vences M, Guayasamin JM, Miralles A, De La Riva I. 2013. To name or not to name: Criteria to promote economy of change in Linnaean classification schemes. Zootaxa 3636: 201–244.

Vidal N. 2002. Colubroid systematics: evidence for an early appearance of the venom apparatus followed by extensive evolutionary tinkering. J. Toxicol. Toxin. Rev. 21: 21–41.

Vidal N, Delmas AS, David P, Cruaud C, Couloux A, Hedges SB. 2007. The phylogeny and classification of caenophidian snakes inferred from seven nuclear protein-coding genes. C R Biol. 330: 182–187.

Wallach V, Williams KL, Boundy J. 2014. Snakes of the World a Catalogue of living and extinct Species. CRC Press, Taylor & Francis Group.

Whitaker R, Captain A. 2004. Snakes of India: The Field Guide. Draco Books, Chennai.

Wiens JJ, Kuczynski CA, Smith SA, Mulcahy DG, Sites JW, Townsend TM, Tod W. 2008. Branch Lengths, Support, and Congruence: Testing the Phylogenomic Approach with 20 Nuclear Loci in Snakes. Sys Biol. 57: 420–431.

Wilkinson M, San Mauro D, Sherratt E, Gower DJ. 2011. A nine-family classification of caecilians (Amphibia: Gymnophiona). Zootaxa 2874: 41–64.

Zaher H. 1999. Hemipenial morphology of the South American xenodontine snakes, with a proposal for a monophyletic Xenodontinae and a reappraisal of colubroid hemipenes. Bull Am Mus Nat Hist. 240: 1–168.

Zaher H, Grazziotin FG, Cadle JE, Murphy RW, Moura-Leite JCD, Bonatto SL. 2009. Molecular phylogeny of advanced snakes (Serpentes, Caenophidia) with an emphasis on South American Xenodontines: a revised classification and descriptions of new taxa. Pap Avulsos Zool. (São Paulo). 49: 115–153.

Zaher H, Grazziotin FG, Graboski R, Fuentes RG, Sánchez-Martinez P, Montingelli GG, Zhang Y-P, Murphy RW. 2012. Phylogenetic relationships of the genus Sibynophis (Serpentes: Colubroidea). Pap Avulsos Zool. (São Paulo). 52: 141–149.

FIGURES

Figure 1. Pruned ML tree showing bootstrap support for the relationships of species in the family Pareidae. See Appendix 4 for the complete ML phylogeny including 507 taxa (493 species of snakes and 7 non-snake squamates).

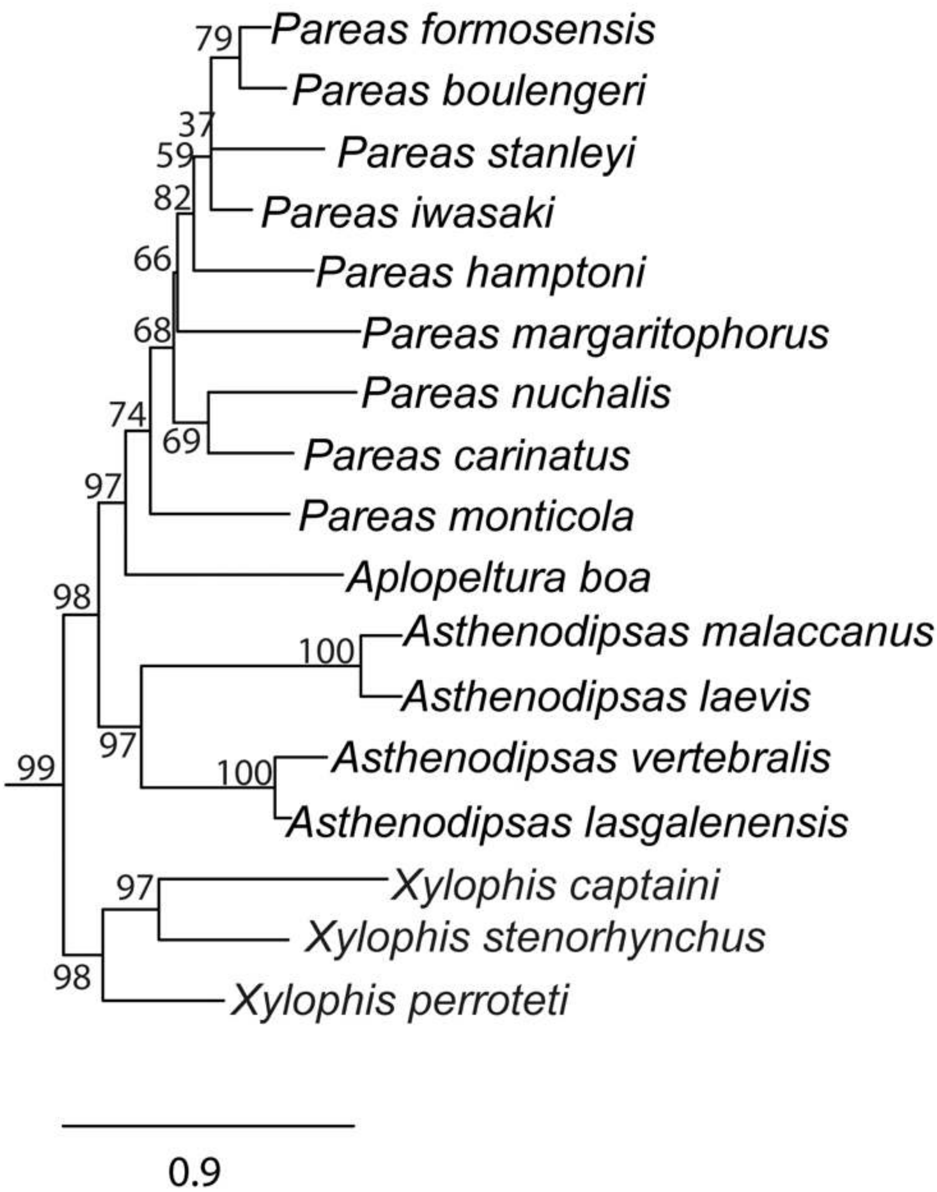


Figure 2. Ranges of uncorrected p-distances (black & grey) and K2P distances (dark blue & light blue) for between-family (dark bars) and within-family (light bars) comparisons of snakes in the superfamily Colubroidea. Pareidae here includes Pareinae and Xylophiinae subfam. nov. Numbers on the X axis denotes sample size of subfamilies under each family.

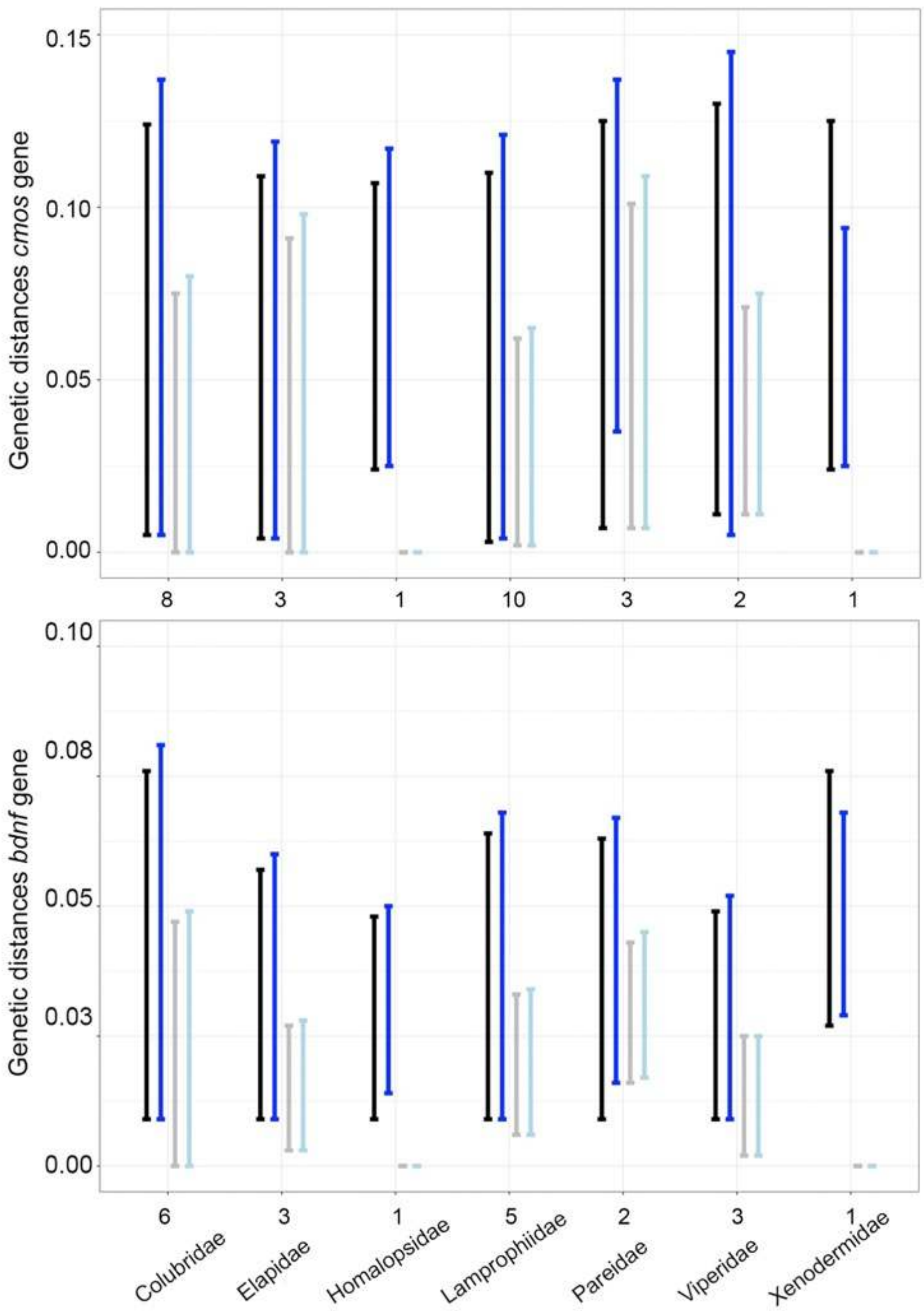


Figure 3. BEAST chronogram generated using concatenated-gene for all families and subfamilies of snakes. Numbers at internal branches indicate posterior probabilities. Error bars indicate 95% Highest Posterior Densities for node ages. Nodes C1–C5 are the five calibrated nodes

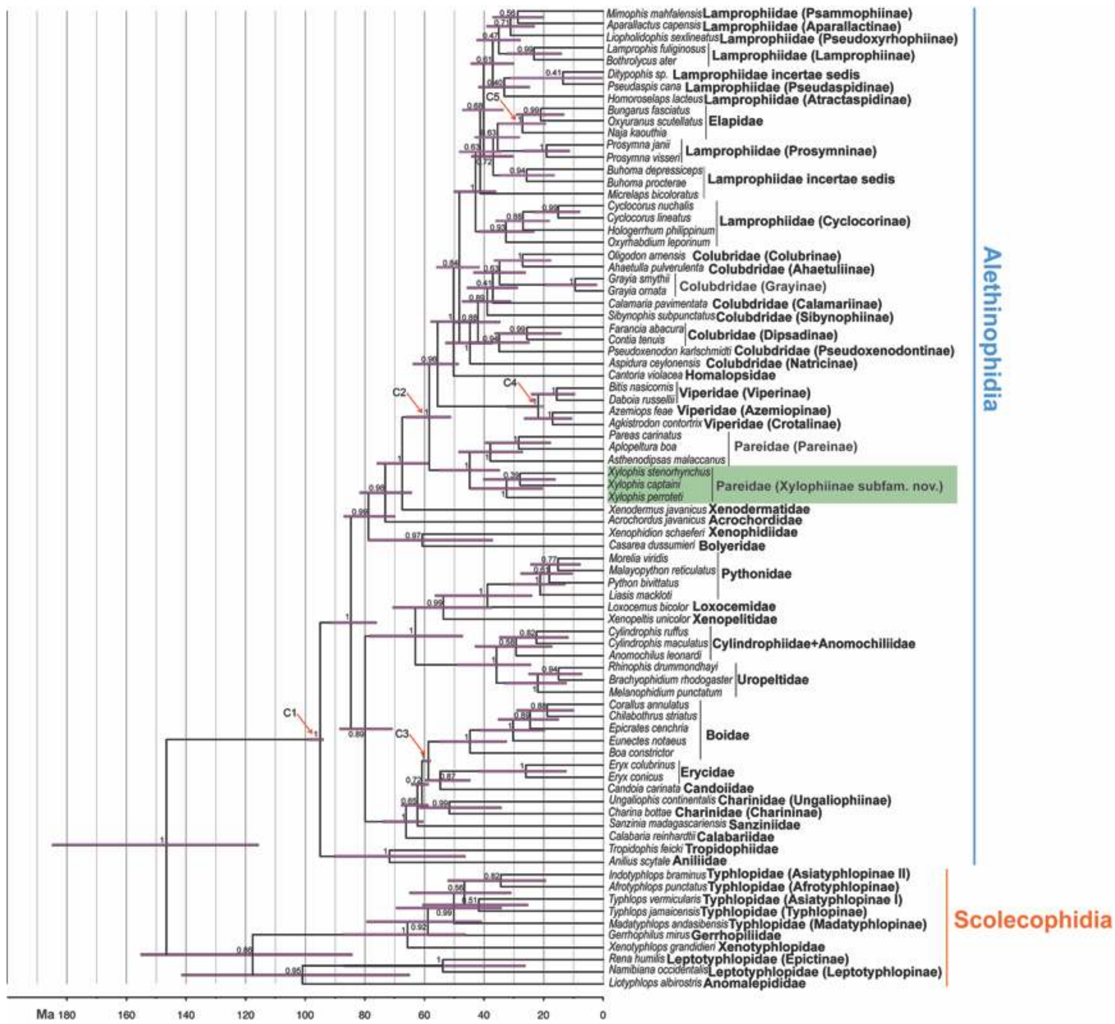


Figure 4. A. Geographic distribution of Xylophiinae subfam. nov. (green) and approximate distribution of subfamily Pareinae (blue). Photographs show representative taxa of the two subfamilies within Pareidae: B. *Xylophis perroteti* from Nilgiris, Tamil Nadu, India. C. *Pareas monticola* from Barail, Assam, India. Approximate distribution drawn based on locations provided in Srinivasulu et al (2014) and Wallach et al (2014).

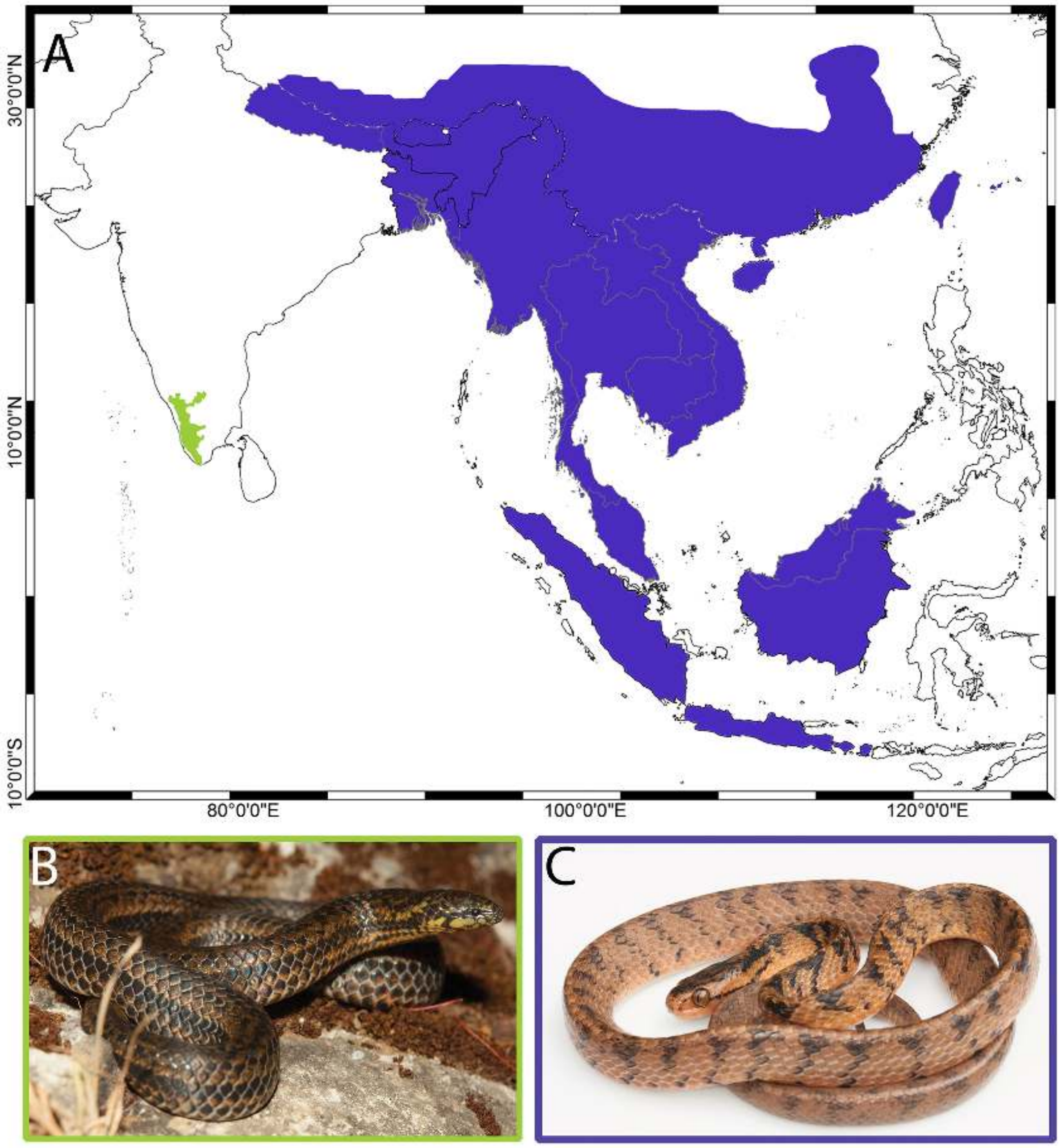


Table 1. GenBank accession and voucher numbers for gene sequences used in molecular dating analysis. * indicates data used in the "map to reference" analyses to identify homologous sequences from UCE data for the historical sample of *X. stenorhynchus*.

sno	species	family (subfamily)	*cytb*	*16s*	*nd4*	*cmos*	*bdnf*	*rag1*
1	*Acrochordus javanicus*	Acrochordidae	_	AF512745	HM234055	HM234058	AY988036	HM234061
2	*Afrotyphlops punctatus*	Typhlopidae (Afrotyphlopinae)	_	_	_	_	GU902395	_
3	*Agkistrodon contortrix*	Viperidae (Crotalinae)	EU483383	AF156566	AF156577	_	EU402623	EU402833
4	*Ahaetulla pulverulenta*	Colubridae (Ahaetuliinae)	KC347454	KC347339	KC347512	KC347378	_	KC347416
5	*Anilius scytale*	Aniliidae	U69738	FJ755180	FJ755180	AF544722	EU402625	AY988072
6	*Anomochilus leonardi*	Cylindrophiidae+Anomochiliidae	_	AY953431	_	_	_	_
7	*Aparallactus capensis*	Lamprophiidae (Aparallactinae)	AY188006	AY188045	FJ404331	AY187967	_	_
8	*Aplopeltura boa*	Pareidae (Pareinae)	JF827673	AF544787	JF827650	JF827696	FJ433984	_
9	*Aspidura ceylonensis*	Colubridae (Natricinae)	KC347477	KC347361	KC347527	KC347400	_	KC347438
10	*Asthenodipsas malaccanus*	Pareidae (Pareinae)	KX660469	KX660197	KX660597	KX660336	_	_
11	*Azemiops feae*	Viperidae (Azemiopinae)	AY352747	AF057234	AY352808	AF544695	EU402628	EU402836
12	*Bitis nasicornis*	Viperidae (Viperinae)	DQ305457	AY188048	DQ305475	AY187970	_	KC330012
13	*Boa constrictor*	Boidae	AB177354	AB177354	AB177354	AF544676	KC330044	KC347423
14	*Boaedon fuliginosus*	Lamprophiidae (Lamprophiinae)	AF471060	AY188079	FJ404365	FJ404270	EU402646	EU402849
15	*Bothrolycus ater*	Lamprophiidae (Lamprophiinae)	AY612041	AY611859	AY611950	FJ404347	_	_
16	*Brachyophidium rhodogaster*	Uropeltidae	_	AY701023	_	_	_	_
17	*Buhoma depressiceps*	Lamprophiidae *incertae sedis*	AY612042	AY611860	_	AY611951	_	_

18	*Buhoma procterae*	Lamprophiidae *incertae sedis*	AY612001	AY611818	DQ486328	AY611910	_	_
19	*Bungarus fasciatus*	Elapidae	EU579523	EU579523	EU579523	AY058924	FJ433989	_
20	*Calabaria reinhardtii*	Calabariidae	AY099985	Z46494	_	AF544682	EU402631	EU402839
21	*Calamaria pavimentata*	Colubridae (Calamariinae)	AF471081	KX694624	_	AF471103	FJ434005	_
22	*Candoia carinata*	Candoiidae	AY099984	EU419850	_	AY099961	FJ433974	AY988065
23	*Cantoria violacea*	Homalopsidae	EF395897	KX694627	EF395922	_	_	_
24	*Casarea dussumieri*	Bolyeridae	U69755	AF544827	_	AF544731	EU402632	EU402840
25	*Charina bottae*	Charinidae (Charininae)	AY099986	AF544816	AF302959	AY099971	FJ433978	AY988076
26	*Chilabothrus striatus*	Boidae	_	_	KC329966	KC329991	KC330056	KC330027
27	*Contia tenuis*	Colubridae (Dipsadinae)	GU112384	AY577030	GU112419	AF471134	GU112346	_
28	*Corallus annulatus*	Boidae	KC750012	_	KC750018	KC750007	JX576167	KC750047
29	*Cyclocorus nuchalis*	Lamprophiidae (Cyclocorinae)	MG458754	_	_	MG458764	_	_
30	*Cyclocorus lineatus*	Lamprophiidae (Cyclocorinae)	MG458750	_	_	MG458759	_	_
31	*Cylindrophis maculatus*	Cylindrophiidae+Anomochilidae	KC347460	KC347355	KC347494	KC347395	_	KC347433
32	*Cylindrophis ruffus*	Cylindrophiidae+Anomochilidae	AB179619	AB179619	AB179619	AF471133	AY988037	AY988071
33	*Daboia russellii*	Viperidae (Viperinae)	EU913478	EU913478	EU913478	AF471156	EU402636	EU402843
34	*Ditypophis sp.*	Lamprophiidae	_	_	_	_	JQ073079	JQ073200
35	*Epicrates cenchria*	Boidae	HQ399501	_	KC329975	KC330008	KC330073	_
36	*Eryx colubrinus*	Erycidae	U69811	AF544819	_	AF544716	EU402639	DQ465571
37	*Eryx conicus*	Erycidae	GQ225658	AF512743	GQ225672	_	_	AY988074
38	*Eunectes notaeus*	Boidae	HQ399499	AM236347	KC329978	HQ399536	KC330076	HQ399516
39	*Farancia abacura*	Colubridae (Dipsadinae)	U69832	Z46491	U49307	AF471141	_	KR814740

40	*Gerrhopilus mirus*	Gerrhopilidae	AM236345	AM236345	AM236345	_	GU902394	_
41	*Grayia ornata*	Colubridae (Grayiinae)	_	AF158503	AF544663	AF544684	FJ434002	_
42	*Grayia smythii*	Colubridae (Grayiinae)	DQ112077	_	DQ112080	_	_	_
43	*Hologerrhum philippinum*	Lamprophiidae (Cyclocorinae)	MG458758	_	_	MG458766	_	_
44	*Homoroselaps lacteus*	Lamprophiidae (Atractaspidinae)	AY611992	AY611809	FJ404338	AY611901	JQ599029	_
45	*Indotyphlops braminus*	Typhlopidae (Asiatyphlopinae II)	DQ343649	_	_	AF544717	FJ433959	_
46	*Liasis mackloti*	Pythonidae	U69839	EF545051	_	AF544726	FJ433970	_
47	*Liopholidophis sexlineatus*	Lamprophiidae (Pseudoxyrhophiinae)	DQ979985	AY188063	FJ404373	AY187985	_	_
48	*Liotyphlops albirostris*	Anomalepididae	AF544672	AF366762	_	AF544727	EU402650	EU402853
49	*Loxocemus bicolor*	Loxocemidae	AY099993	AF544828	_	AY444035	EU402651	_
50	*Madatyphlops andasibensis*	Typhlopidae (Madatyphlopinae)	_	_	_	_	GU902453	JQ073249
51	*Malayopython reticulatus*	Pythonidae	U69860	EF545062	_	AF544675	FJ433969	EU624119
52	*Melanophidium punctatum*	Uropeltidae	_	AY701024	_	_	_	_
53	*Micrelaps bicoloratus*	Lamprophiidae (Aparallactinae)	DQ486349	_	_	DQ486173	_	_
54	*Mimophis mahfalensis*	Lamprophiidae (Psammophiinae)	DQ486461	AY188070	_	AY187992	JQ073081	_
55	*Morelia viridis*	Pythonidae	EF545098	EF545048	_	_	_	_
56	*Naja kaouthia*	Elapidae	FR693728	GQ359757	EU624209	AY058938	EU402654	EU402857
57	*Namibiana occidentalis*	Leptotyphlopidae (Leptotyphlopinae)	_	GQ469251	_	GQ469074	GQ469189	_
58	*Oligodon arnensis*	Colubridae (Colubrinae)	KC347464	KC347365	KC347504	KC347404	_	KC347442
59	*Oxyrhabdium leporinum*	Lamprophiidae (Cyclocorinae)	AF471029	_	_	DQ112081	_	_
60	*Oxyuranus scutellatus*	Elapidae	EU547051	EU547149	EF210827	EU546916	_	_
61	*Pareas carinatus*	Pareidae (Pareinae)	JF827677	AF544802	JF827653	JF827702	FJ433985	_

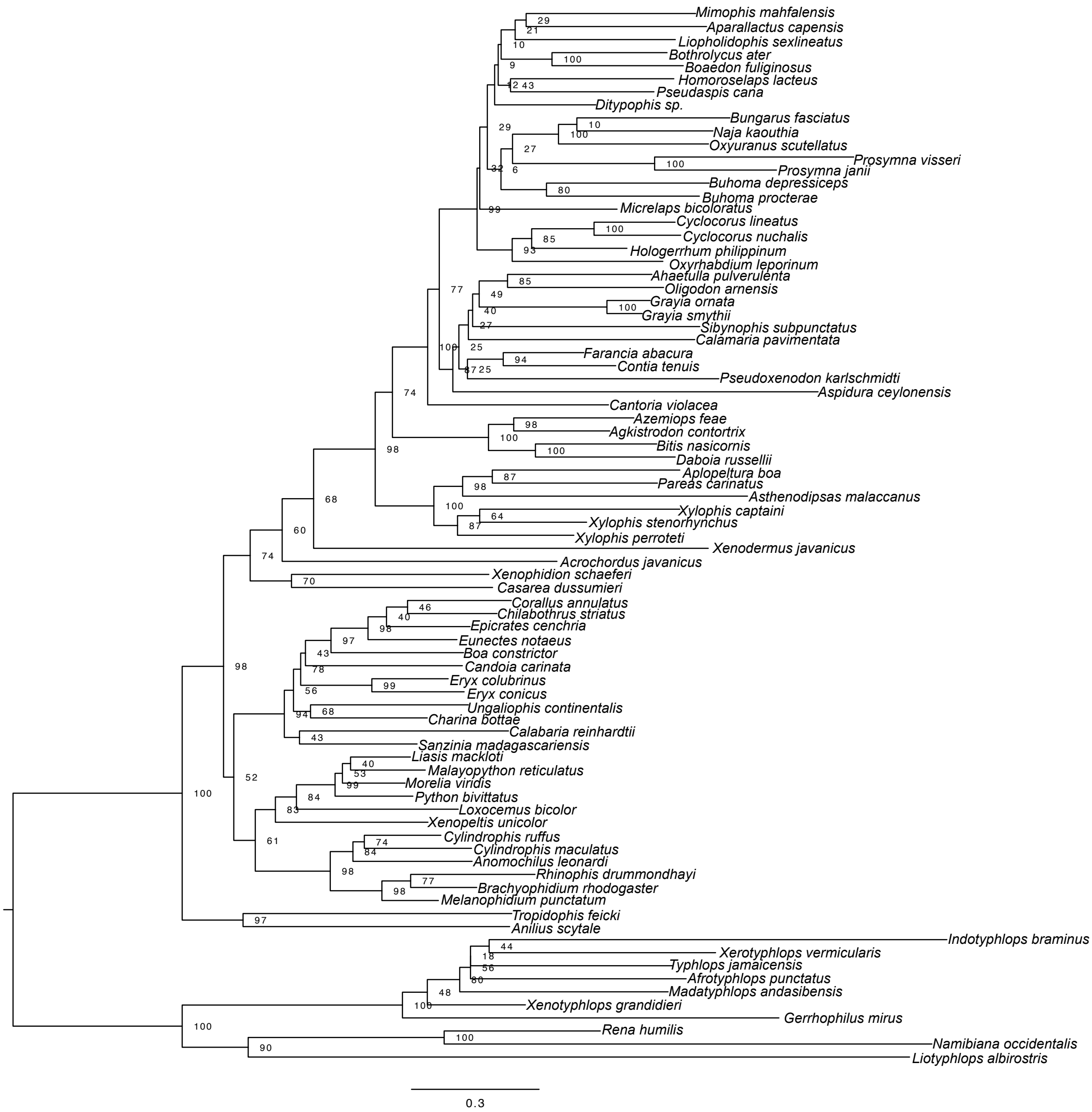
62	*Prosymna janii*	Lamprophiidae (Prosymninae)	FJ404319	FJ404222	FJ404389	FJ404293	_	_
63	*Prosymna visseri*	Lamprophiidae (Prosymninae)	AY188033	AY188072	_	AY187994	_	_
64	*Pseudaspis cana*	Lamprophiidae (Pseudaspidinae)	AY612080	AY611898	DQ486319	DQ486167	_	_
65	*Pseudoxenodon karlschmidti*	Colubridae (Pseudoxenodontinae)	AF471080	JF697330	_	AF471102	JQ599045	_
66	*Python bivittatus*	Pythonidae	JX401131	KF010492	_	AF435016	XM7433022	_
67	*Rena humilis*	Leptotyphlopidae (Epictinae)	AY099991	AB079597	AB079597	AY099979	_	_
68	*Rhinophis drummondhayi*	Uropeltidae	AF544673	AY701028	_	AF544719	FJ433966	_
69	*Sanzinia madagascariensis*	Sanziniidae	U69866	AY336066	_	EU403580	AY988033	AY988067
70	*Sibynophis subpunctatus*	Colubridae (Sibynophiinae)	KC347471	KC347373	KC347516	KC347411	_	KC347449
71	*Tropidophis feicki*	Tropidophiidae	KF811124	AF512733	_	KF811110	KF811074	_
72	*Typhlops jamaicensis*	Typhlopidae (Typhlopinae)	KF993259	AF366764	_	AF544733	EU402664	EU402866
73	*Ungaliophis continentalis*	Charinidae (Ungaliophiinae)	U69870	AF544833	_	AF544724	EU402665	EU402867
74	*Xenodermus javanicus*	Xenodermidae	_	AF544810	U49320	AF544711	EU402667	EU402869
75	*Xenopeltis unicolor*	Xenopeltidae	AB179620	AB179620	AB179620	AF544689	EU402668	DQ465564
76	*Xenophidion schaeferi*	Xenophidiidae	AY574279	_	_	_	_	_
77	*Xenotyphlops grandidieri*	Xenotyphlopidae	KF770844	_	_	_	GU902457	_
78	*Xerotyphlops vermicularis*	Typhlopidae (Asiatyphlopinae I)	JQ910544	_	_	_	GU902397	_
79	*Xylophis perroteti*	Pareidae (Xylophiinae subfam. nov.)	_	MK340908*	MK340910*	MK344193*	MK344197*	MK340913*
80	*Xylophis stenorhynchus*	Pareidae (Xylophiinae subfam. nov.)	MK340915	MK340907	MK340911	MK344194	MK344198	_
81	*Xylophis captaini*	Pareidae (Xylophiinae subfam. nov.)	MK340914*	MK340909*	MK340912	MK344195	MK344196	_

*indicates data used in the 'map to reference' analyses to identify homologous sequences from UCE data for the historical sample of *X. stenorhynchus*.

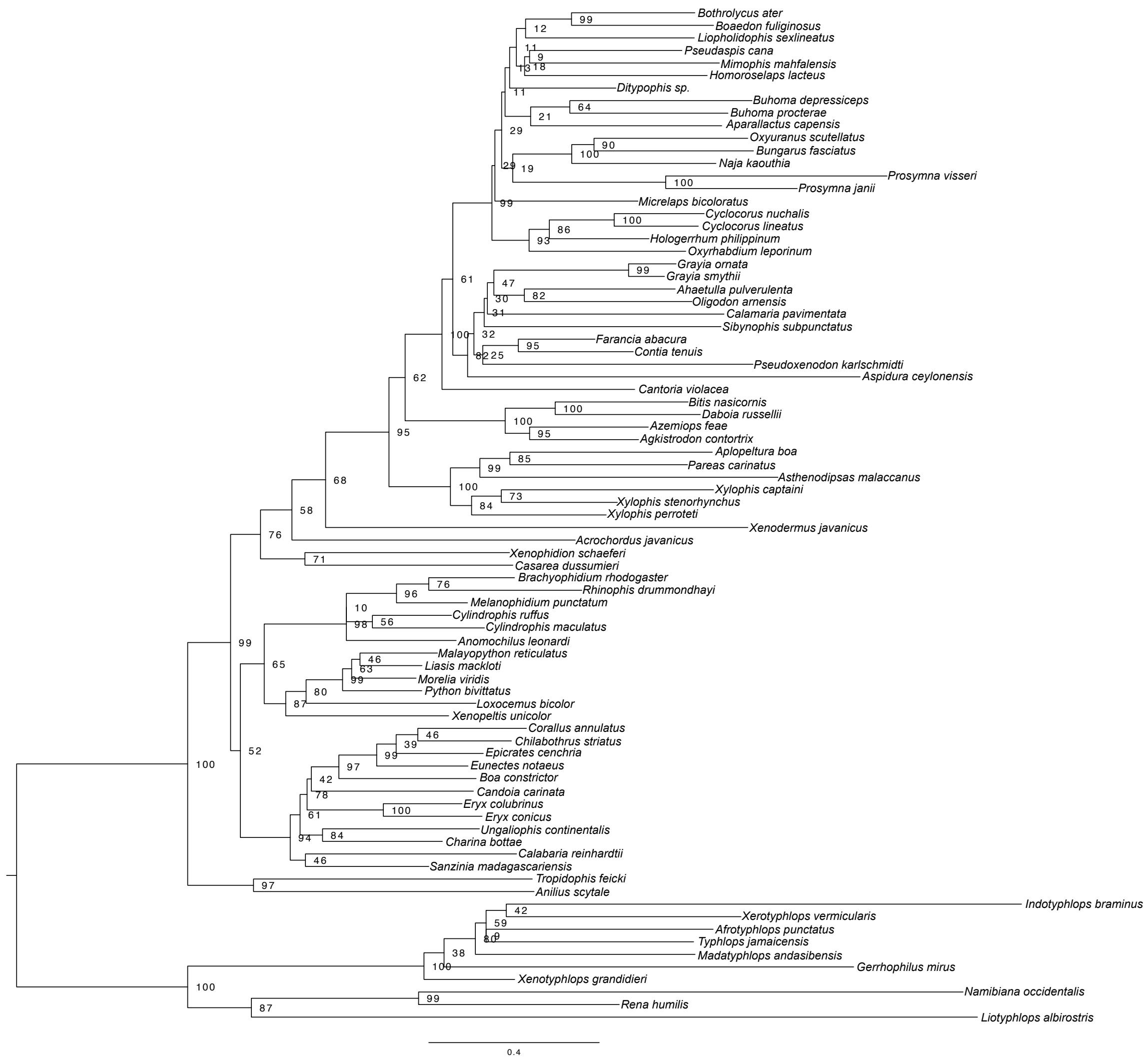
Supplementary material

Figure S1. RAxML trees for concatenated data for 81 taxa, with three different alignment treatments for *16s*.

A) ML tree for concatenated data including *16s* aligned by ClustalW, with all sites included. Numbers on tree are bootstrap values (based on 1,000 replicates). Scale bar indicates substitutions per site.



B) ML tree for concatenated data including *16s* aligned by MUSCLE, with all sites included. Numbers on tree are bootstrap values (based on 1,000 replicates). Scale bar indicates substitutions per site.



C) ML tree for concatenated data including *16s* aligned by ClustalW, with ambiguously aligned sites removed under 'less stringent' option in Gblocks. Numbers on tree are bootstrap values (based on 1,000 replicates). Scale bar indicates substitutions per site.

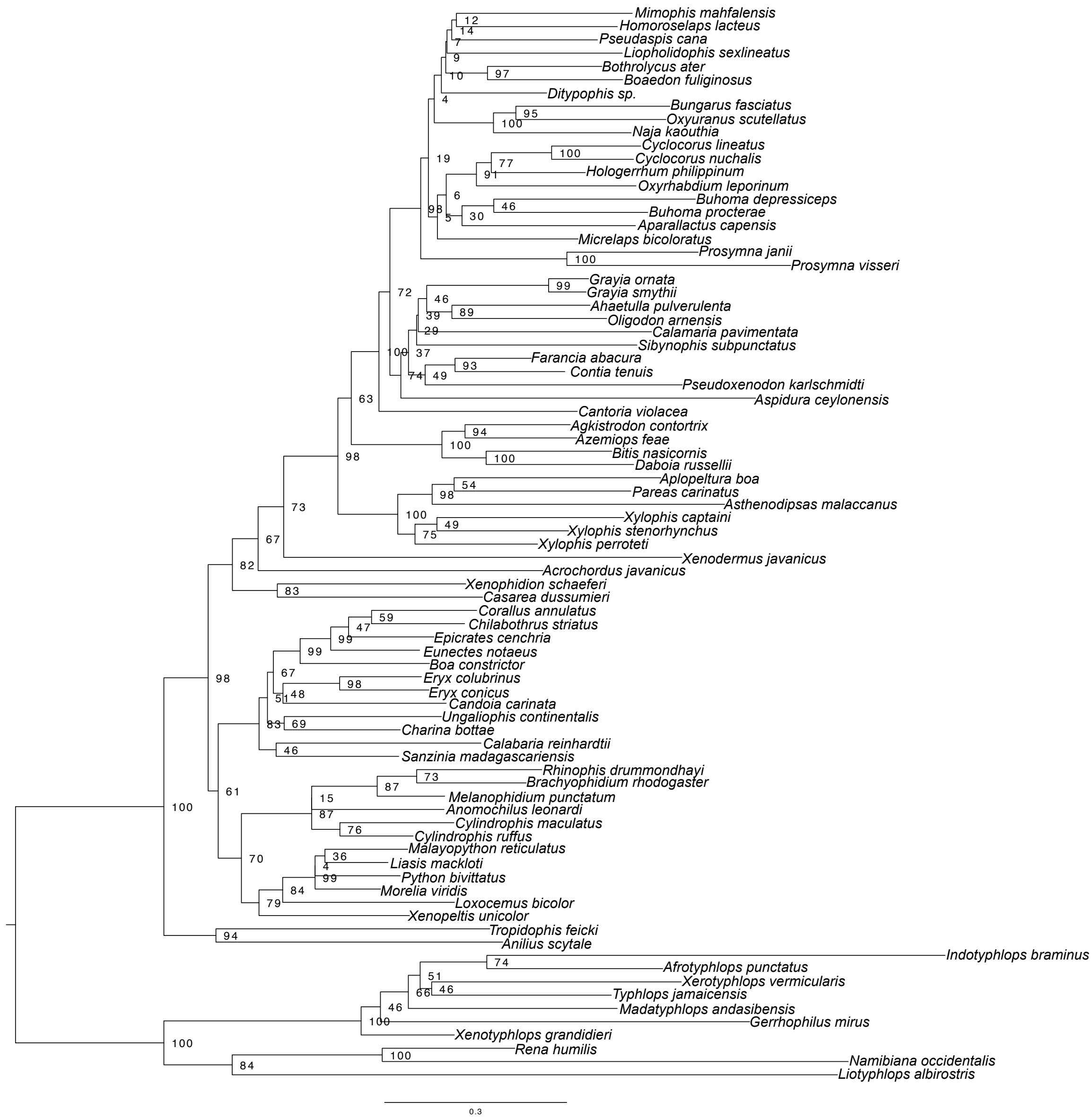


Figure S2. RAxML phylogeny highlighting relationships of the genus *Xylophis*.

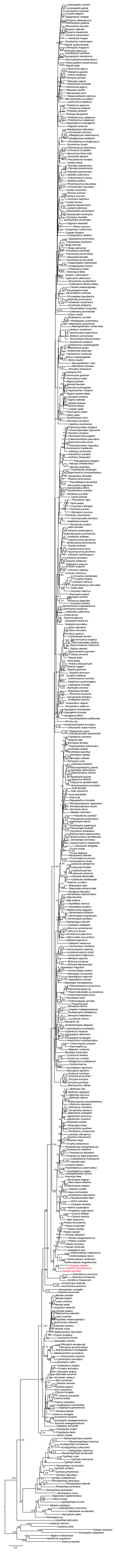
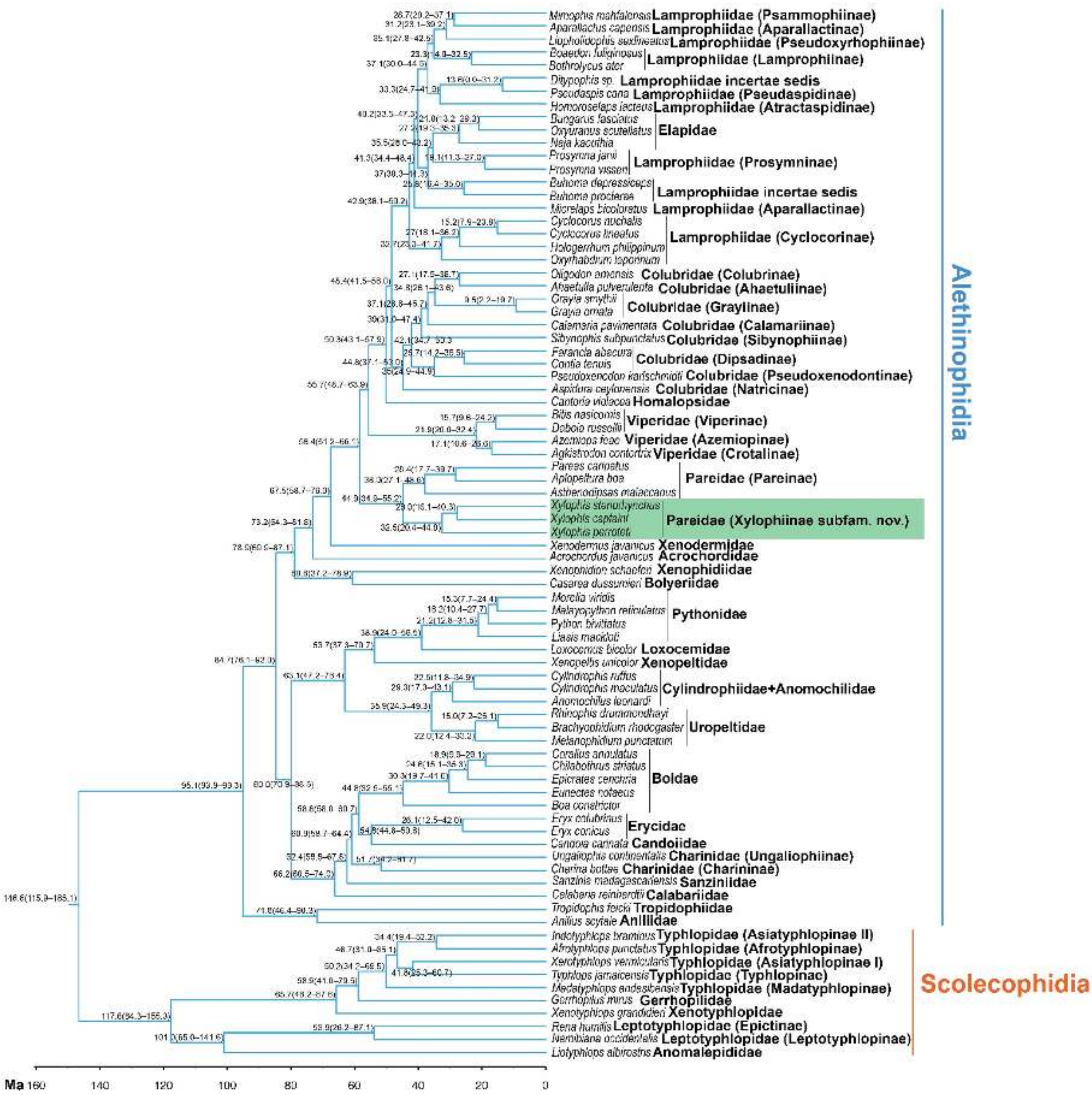


Figure S3. BEAST chronograms generated using concatenated gene sequence data for all families and subfamilies of snakes (81 taxa).

A. Concatenated dataset including all sites. Numbers at internal nodes indicate mean estimated node ages (and 95% highest posterior densities)



B.Concatenated dataset in which third codon position of the mitochondrial genes (nd4 and cytb) are excluded. Numbers at internal nodes indicate mean estimated node ages (and 95% highest posterior densities)

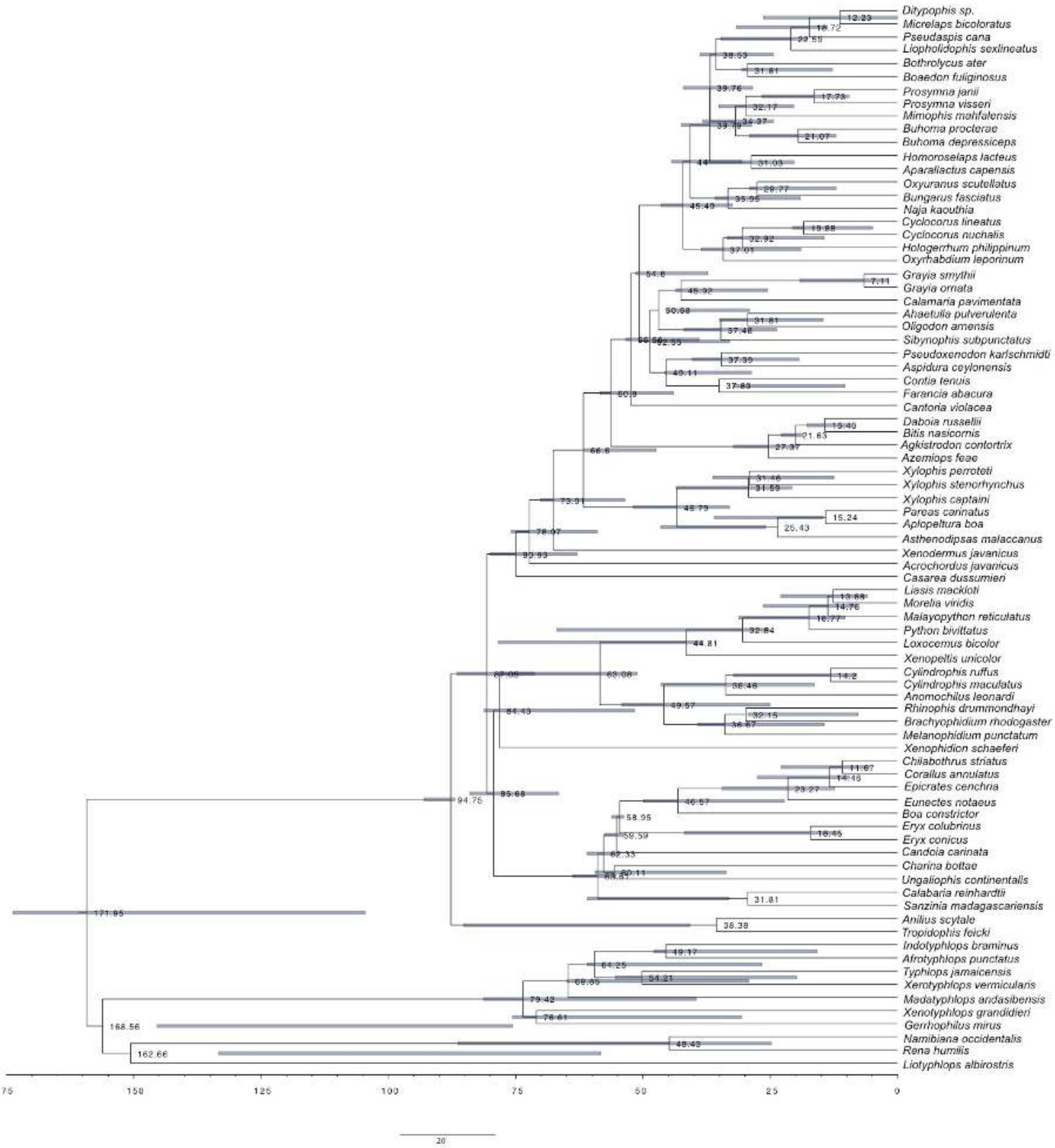


Figure S4. Comparison of estimated mean divergence dates from BEAST analyses of data in which third codon positions of mitochondrial genes (*nd4* and *cytb*) are either included or excluded. Nodes C1–C5 are the five calibrated nodes; Node 42 is the divergence between Pareinae and Xylophiinae subfam. nov. Points are plotted for the 57 out of 80 nodes in common between the two BEAST trees (see Fig. S3).

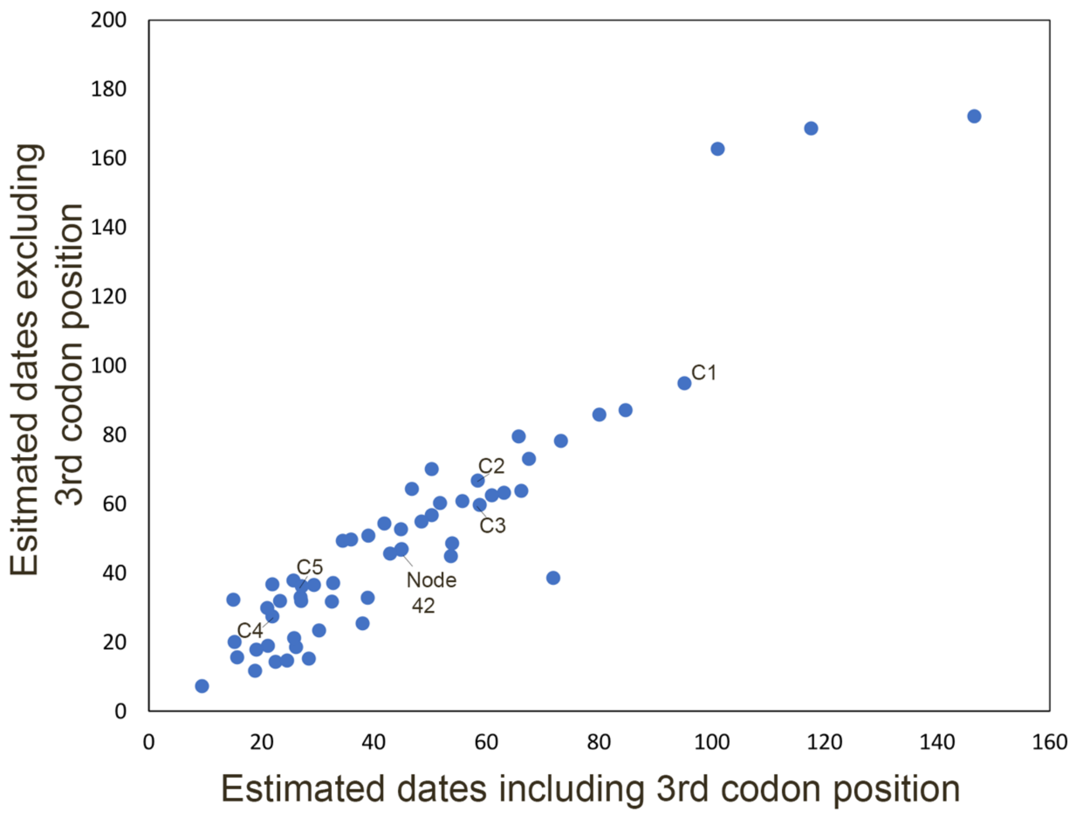


Table S1. GenBank accession and voucher numbers for gene sequences used in Maximum Likelihood analysis.

sno	Species	CYTB	16s	ND4	CMOS	BDNF	RAG1
1	*Acanthophis laevis*	AY340138	_	AY340167	_	_	_
2	*Acanthophis praelongus*	EU547063	EU547161	AY340164	EU546926	_	_
3	*Achalinus meiguensis*	FJ424614	FJ424614	FJ424614	_	_	_
4	*Acrantophis dumerili*	EU403574	EU419794	_	EU403581	AY988032	AY988066
5	*Acrantophis madagascariensis*	U69736	AY336071	_	EU403578	FJ433973	_
6	*Acrochordus arafurae*	_	_	HM234056	_	_	HM234062
7	*Acrochordus javanicus*	_	AF512745	HM234055	HM234058	AY988036	HM234061
8	*Acutotyphlops kunuaensis*	_	_		_	GU902419	_
9	*Acutotyphlops subocularis*	JQ910524	KF993127	_	_	GU902418	_
10	*Adelophis foxi*	KF258652	_	KF258635	_	KF258601	_
11	*Adelphicos quadrivirgatus*	GQ895853	_	_	GQ895796	_	_
12	*Afronatrix anoscopus*	_	_	AF420076	AF471123	EU402622	EU402832
13	*Afrotyphlops punctatus*	_	_		_	GU902395	_
14	*Agkistrodon contortrix*	EU483383	AF156566	AF156577	_	EU402623	EU402833
15	*Agkistrodon piscivorus*	EU483436	AF057278	AF156578	AF471096	JQ599004	_
16	*Ahaetulla mycterizans*	KX660479	KX660205	KX660604	KX660345	_	_
17	*Ahaetulla pulverulenta*	KC347454	KC347339	KC347512	KC347378	_	KC347416
18	*Aipysurus apraefrontalis*	KC014380	JX423420	JX002981	KC014288	_	_
19	*Aipysurus duboisii*	JX423393	JX423423	JX423411	FJ587163	_	_
20	*Alsophis anomalus*	_	FJ666092	_	_	_	_
21	*Alsophis antillensis*	FJ416726	FJ416702	FJ416800	_	JQ599005	_
22	*Alsophis cantherigerus*	AF544669	AF158475	_	_	_	_
23	*Alsophis portoricensis*	_	AF158517	_	_	_	_
24	*Amastridium sapperi*	GQ334479	_	GQ334580	_	_	_
25	*Amastridium veliferum*	_	_	_	GQ895797	_	_
26	*Amphiesma craspedogaster*	JQ687429	_	JQ687412	_	_	_
27	*Amphiesma sauteri*	AF402905	_	_	_	_	_
28	*Amphiesma stolatum*	JQ687432	_	JQ687425	KJ685661	EU402624	_
29	*Amplorhinus multimaculatus*	DQ486340	AY611880	DQ486316	DQ486164	_	_
30	*Anilius scytale*	U69738	FJ755180	FJ755180	AF544722	EU402625	AY988072
31	*Anomochilus leonardi*	_	AY953431	_	_	_	_
32	*Antaresia childreni*	_	EF545058	_	AY099967	_	_
33	*Antillophis andreae*	_	AF158511	_	_	_	_
34	*Antillophis parvifrons*	_	AF158510	_	_	JQ599006	_
35	*Aparallactus capensis*	AY188006	AY188045	FJ404331	AY187967	_	_
36	*Aparallactus werneri*	AF471035	_	U49315	AF471116	EU402626	_
37	*Aplopeltura boa*	JF827673	AF544787	JF827650	JF827696	FJ433984	_
38	*Apostolepis dimidiata*	JQ598917	GQ457725	_	GQ457844	JQ599008	_
39	*Arizona elegans*	DQ902101	_	DQ902279	DQ902058	_	_
40	*Arrhyton dolichura*	FJ416721	AF158507	FJ416795	_	_	_
41	*Arrhyton exiguum*	_	FJ416705	_	_	_	_
42	*Aspidelaps lubricus*	FR693724	_	_	_	_	_
43	*Aspidelaps scutatus*	_	AY188046	AY058969	AY187968	_	_
44	*Aspidites melanocephalus*	U69741	EF545060	_	DQ465557	EU402627	DQ465560
45	*Aspidomorphus lineaticollis*	_	GQ397237	_	GQ397227	_	_

46	*Aspidura ceylonensis*	KC347477	KC347361	KC347527	KC347400	_	KC347438
47	*Asthenodipsas laevis*	KX660468	KX660196	KX660596	KX660335	_	_
48	*Asthenodipsas lasgalenensis*	KC916763	_	_	_	_	_
49	*Asthenodipsas malaccanus*	KX660469	KX660197	KX660597	KX660336	_	_
50	*Asthenodipsas vertebralis*	KC916750	_	_	_	_	_
51	*Atheris squamigera*	AJ275684	AF544788	EU624212	AF544734	_	_
52	*Atractaspis irregularis*	_	_		_	JN614212	_
53	*Atractaspis micropholis*	AY612006	AY611823	FJ404336	AY611915	FJ433994	_
54	*Atractus albuquerquei*	JQ598918	GQ457726	_	GQ457845	JQ599009	_
55	*Atractus wagleri*	GQ334480	_	GQ334581	_	_	_
56	*Atretium schistosum*	KC347487	_	KC347525	KC347383	_	KC347421
57	*Atretium yunnanensis*	GQ281787	_	JQ687423	JQ687448	_	_
58	*Atropoides olmec*	AY223585	AY223669	AY223632	_	_	_
59	*Atropoides picadoi*	AY220324	AF057255	AY220347	_	_	_
60	*Austrelaps labialis*	EU547077	EU547175	EU547029	EU546939	_	_
61	*Austrelaps superbus*	EU547078	EU547176	EU547030	EU546940	_	_
62	*Azemiops feae*	AY352747	AF057234	AY352808	AF544695	EU402628	EU402836
63	*Balanophis ceylonensis*	KC347474	KC347344	KC347520	KC347384	_	KC347422
64	*Bitis nasicornis*	DQ305457	AY188048	DQ305475	AY187970	_	KC330012
65	*Boa constrictor*	AB177354	AB177354	AB177354	AF544676	KC330044	KC347423
66	*Bogertophis rosaliae*	DQ902102	_	DQ902280	DQ902059	_	_
67	*Boiga barnesii*	KC347469	KC347345	KC347499	KC347385	_	_
68	*Boiga siamensis*	KX660527	KX660257	KX660645	KX660398	_	_
69	*Borikenophis portoricensis*	AF471085	_	FJ416806	AF471126	JQ599012	_
70	*Bothriechis schlegeliil*	KC847272	KC847257	KC847285	_	FJ433983	_
71	*Bothrochilus albertisii*	_	_	_	KF811096	KF811059	KF811160
72	*Bothrocophias microphthalmus*	FR691567	AY223670	FR691540	_	_	_
73	*Bothrops leucurus*	EU867279	EU867267	AF246283	_	_	_
74	*Bothrops lojanus*	FR691566	_	FR691536	_	_	_
75	*Bothrops lutzi*	KF801130	_	KF801261	_	_	_
76	*Bothrops oligolepis*	_	KX660260	KX660646	_	_	_
77	*Brachyophidium rhodogaster*	_	AY701023	_	_	_	_
78	*Brachyorrhos raffrayi*	JX139713	_	_	_	_	_
79	*Brachyurophis approximans*	_	KF736330	_	_	_	_
80	*Brachyurophis semifasciata*	EU547057	EU547155	EU547011	EU546921	_	_
81	*Buhoma depressiceps*	AY612042	AY611860	_	AY611951	_	_
82	*Buhoma procterae*	AY612001	AY611818	DQ486328	AY611910	_	_
83	*Bungarus fasciatus*	EU579523	EU579523	EU579523	AY058924	FJ433989	_
84	*Caaeteboia amarali*	JQ598921	_	_	_	_	_
85	*Calabaria reinhardtii*	AY099985	Z46494	_	AF544682	EU402631	EU402839
86	*Calamaria pavimentata*	AF471081	KX694624	_	AF471103	FJ434005	_
87	*Calamodontophis paucidens*	_	GQ457728	_	GQ457848	_	_
88	*Calliophis calligaster*	EF137411	_	EF137403	EF137419	_	_
89	*Calliophis japonicus*	AF217831	_	_	_	_	_
90	*Calliophis melanurus*	KC347458	KC347351	KC347502	KC347391	_	KC347429
91	*Calloselasma rhodostoma*	AY223562	AY352718	AY352813	_	_	_
92	*Calotes versicolor*	AY572870	JX668217	JX857560	JX838985	DQ340705	_
93	*Candoia aspera*	U69751	EF545068	_	_	_	_

94	*Candoia carinata*	AY099984	EU419850	_	AY099961	FJ433974	AY988065
95	*Caraiba andreae*	FJ416743	_	FJ416817	_	_	_
96	*Carphophis amoenus*	AF471067	AY577022	_	DQ112082	_	_
97	*Casarea dussumieri*	U69755	AF544827	_	AF544731	EU402632	EU402840
98	*Causus defilippi*	GU045452	GU045452	AY223617	_	EU402633	_
99	*Causus resimus*	AY223555	AY223662	AY223616	AF544696	_	_
100	*Cemophora coccinea*	KF216147	_	DQ902282	AF471132	_	_
101	*Cerastes cerastes*	AF471028	HQ267811	EU624222	AF544679	_	EU852329
102	*Cerberus rynchops*	EF395900	EF395851	U49327	EF395925	_	_
103	*Cerrophidion barbouri*	HM363641	HM363640	HM363642	_	_	_
104	*Cerrophidion godmani*	AY220328	DQ305442	AY220349	_	_	_
105	*Chamaeleo calyptratus*	NC12420	HF570443	HF570566	HF570667	GU457847	_
106	*Charina bottae*	AY099986	AF544816	AF302959	AY099971	FJ433978	AY988076
107	*Charina reinhardtii*	_	_	AF302943	_	_	_
108	*Charina trivirgata*	_	GQ200595	AF302944	_	EU402649	EU402852
109	*Charina umbratica*	KF811115	_	AF302977	KF811099	KF811062	KF811163
110	*Chilabothrus striatus*	_	_	KC329966	KC329991	KC330056	KC330027
111	*Chilomeniscus cinctus*	_	_	U49305	_	_	_
112	*Chilomeniscus stramineus*	GQ895856	_	_	GQ895800	_	_
113	*Chionactis occipitalis*	GQ895857	_	_	GQ895801	_	_
114	*Chironius scurrulus*	KX660434	KX660156	KX660560	KX660295	_	_
115	*Chironius scurrulus*	KX660535	KX660265	_	_	_	_
116	*Chrysopelea taprobanica*	KC347459	KC347354	KM673290	KC347394	_	KC347432
117	*Clelia clelia*	GQ895859	AF158472	_	JQ598973	_	_
118	*Clonophis kirtlandii*	KF258647	_	KF258630	_	KF258596	_
119	*Coelognathus radiatus*	DQ902121	_	DQ902317	DQ902079	_	_
120	*Coluber algirus*	_	AY643349	_	_	_	_
121	*Coluber constrictor priapus*	AY486914	L01770	AY487041	AY486938	EU402634	EU402841
122	*Coluber dorri*	AY188040	AY188081	AY487042	AY188001	_	_
123	*Coluber zebrinus*	AY188043	AY188084	AY487058	AY188004	_	_
124	*Compsophis albiventris*	_	AY188050	FJ404351	AY187972	_	_
125	*Compsophis boulengeri*	EF203995	EF204007	_	EF204001	_	_
126	*Coniophanes fissidens*	EF078538	_	EF078586	_	_	_
127	*Conophis lineatus*	JQ598924	GU018161	_	JQ598975	JQ599016	_
128	*Contia tenuis*	GU112384	AY577030	GU112419	AF471134	GU112346	_
129	*Corallus annulatus*	KC750012	_	KC750018	KC750007	JX576167	KC750047
130	*Crotaphopeltis hotamboeia*	AF428023	_	_	_	_	_
131	*Crotaphopeltis tornieri*	AF471093	_	_	AF471112	_	_
132	*Cryophis hallbergi*	GQ334481	_	GQ334582	GQ895807	_	_
133	*Cubophis cantherigerus*	_	_	FJ416818	AF544694	FJ433999	_
134	*Cyclocorinae sp*	MG458751	_	_	MG458760	_	_
135	*Cyclocorus lineatus*	MG458754	_	_	MG458764	_	_
136	*Cyclocorus nuchalis*	MG458750	_	_	MG458759	_	_
137	*Cyclophiops multicinctus*	KX660435	KX660157	_	KX660296	_	
138	*Cylindrophis maculatus*	KC347460	KC347355	KC347494	KC347395	_	KC347433
139	*Cylindrophis ruffus*	AB179619	AB179619	AB179619	AF471133	AY988037	AY988071
140	*Daboia russellii*	EU913478	EU913478	EU913478	AF471156	EU402636	EU402843
141	*Dasypeltis fasciata*	KX660463	KX660190	KX660589	KX660328	_	_

142	*Deinagkistrodon acutus*	EU913476	EU913476	EU913476	_	_	_
143	*Demansia vestigiata*	EU547045	EU547143	EU547003	AY058927	_	_
144	*Dendrelaphis marenae*	KX660515	KX660245	_	KX660386	_	_
145	*Dendrelaphis tristis*	KC347462	KC347359	KC347493	KC347398	_	KC347436
146	*Dendroaspis angusticeps*	_	FJ404194	JF357927	AF544735	FJ433988	_
147	*Dendroaspis jamesoni*	KX660464	KX660191	KX660590	KX660329	_	_
148	*Dendroaspis polylepis*	FJ404295	_	AY058974	FJ387197	_	_
149	*Dendrophidion dendrophis*	GQ895865	_	_	GQ895809	_	_
150	*Dendrophidion percarinatum*	KX660556	KX660291	KX660667	KX660431	_	_
151	*Dendrophidion percarinatus*	_	HM582217	_	HQ157822	_	_
152	*Denisonia devisi*	EU547071	EU547169	EU547023	EU546933	_	_
153	*Diadophis punctatus*	AF471094	AF544793	EU194091	AF471122	EU402637	_
154	*Dinodon rufozonatum*	AF471063	HM439982	KF732917	JF827695	JQ599018	_
155	*Dipsadoboa brevirostris*	_	KX660285	KX660661	KX660424	_	_
156	*Dipsadoboa duchesnii*	KX660453	KX660180	_	KX660319	_	_
157	*Dipsas catesbyi*	JQ598926	Z46496	_	JQ598977	JQ599021	_
158	*Dipsas peruana*	KX660538	KX660269	_	KX660406	_	_
159	*Dipsas pratti*	GQ334482	_	GQ334583	_	_	_
160	*Ditypophis sp.*	_	_		_	JQ073079	JQ073200
161	*Drymarchon corais*	AF471064	HM582218	DQ902314	AF471137	_	_
162	*Drymobius rhombifer*	GQ927320	HM582220	_	GQ927313	_	_
163	*Drymoluber dichrous*	GQ895869	HM582221	_	HQ157824	_	_
164	*Dryophiops philippina*	KX660517	KX660247	KX660641	KX660388	_	_
165	*Echinanthera undulata*	JQ598929	JQ598870	_	JQ598978	JQ599022	_
166	*Echiopsis atriceps*	EU547080	EU547178	EU547032	EU546942	_	_
167	*Echiopsis curta*	EU547072	EU547170	EU547024	EU546934	_	_
168	*Echis carinatus*	GQ359436	GQ359685	GQ359524	_	_	EU852325
169	*Eirenis modestus*	AY486933	AY376792	AY487072	AY486957	_	_
170	*Elaphe bella*	DQ902134	_	DQ902316	DQ902097	_	_
171	*Elaphe poryphyracea*	_	GQ181130	GQ181130	_	_	_
172	*Elaphe quatuorlineata*	AY486931	AF215267	AY487067	AY486955	_	_
173	*Elapognathus coronata*	EU547069	EU547167	EU547021	EU546931	_	_
174	*Elapomorphus quinquelineatus*	JQ598930	GQ457735	_	GQ457855	JQ599023	_
175	*Elapsoidea nigra*	AF217820	_	AY058975	AY058930	_	_
176	*Elapsoidea semiannulata*	AF039260	JF357946	JF357928	AF544678	FJ433987	_
177	*Elgaria multicarinata*	AF361528	AY649151	DQ364660	AF039479	GU457854	GU457977
178	*Emydocephalus annulatus*	DQ233940	DQ234001	FJ593196	FJ587172	_	_
179	*Enhydris dussumieri*	JX463014	JX463016	_	JX463012	_	_
180	*Enhydris enhydris*	EF395904	EF395855	GU997190	EF395929	_	_
181	*Enhydris plumbea*	EF395910	EF395861	U49328	EF395934	_	_
182	*Enulius sp.*	GQ895870	_	_	GQ895813	_	_
183	*Ephalophis greyae*	JX002976	FJ587208	FJ593197	FJ587173	_	_
184	*Epicrates cenchria*	HQ399501	_	KC329975	KC330008	KC330073	_
185	*Epicrates striatus*	U69791	_	_	_	_	_
186	*Eristicophis macmahoni*	AJ275711	EU624293	EU624227	_	_	_
187	*Erythrolamprus aesculapii*	GQ895871	GQ457736	_	GQ895814	JQ599024	_
188	*Eryx colubrinus*	U69811	AF544819	_	AF544716	EU402639	DQ465571
189	*Eunectes notaeus*	HQ399499	AM236347	KC329978	HQ399536	KC330076	HQ399516

190	*Euprepiophis mandarinus*	DQ902115	_	DQ902294	DQ902073	_	_
191	*Euprepiophis perlacea*	KF669239	KF850472	KF850472	_	_	_
192	*Exallodontophis albignaci*	EU394724	_	_	_	_	_
193	*Exiliboa placata*	AY099989	AF512742	_	AY099973	EU402640	AY988068
194	*Farancia abacura*	U69832	Z46491	U49307	AF471141	_	KR814740
195	*Furina diadema*	EU547053	EU547151	EU547008	EU546917	_	_
196	*Furina ornata*	EU547054	EU547152	EU547009	EU546918	_	_
197	*Geophis carinosus*	GQ895872	_	_	GQ895815	_	_
198	*Geophis godmani*	JQ598932	JQ598877	_	_	JQ599026	_
199	*Gloydius brevicaudus*	JQ687496	_	JQ687477	JQ687515	_	_
200	*Gloydius halys*	AY223564	AF057238	JQ356856	_	_	_
201	*Gomesophis brasiliensis*	_	GQ457737	_	_	_	_
202	*Gonionotophis capensis*	_	AF544798	_	AF544703	FJ433995	_
203	*Gonyosoma oxycephalum*	AF471084	Z46490	DQ902309	KC010302	_	_
204	*Grayia ornata*	_	AF158503	AF544663	AF544684	FJ434002	_
205	*Hapsidophrys smaragdina*	AY612057	AY611875	_	DQ112078	FJ434003	_
206	*Hebius craspedogaster*	_	_	_	KJ685622	_	_
207	*Hebius sauteri*	_	_	_	KJ685651	_	_
208	*Helicops angulatus*	AF471037	GQ457738	_	AF471160	JQ599027	_
209	*Helicops infrataeniatus*	JQ598933	GQ457740	_	GQ457859	_	_
210	*Helicops pictiventris*	_	_	U49310	_	_	_
211	*Heloderma suspectum*	NC8776	NC_8776	NC_8776	AY487348	GU457856	GU457979
212	*Hemachatus haemachatus*	AF217821	_	_	_	_	_
213	*Hemerophis socotrae*	AY188042	AY188083	AY487055	AY188003	_	_
214	*Hemiaspis damelii*	EU547073	DQ233979	FJ593193	FJ587161	_	_
215	*Hemiaspis signata*	EU547074	DQ233980	EU547026	EU546936	_	_
216	*Hemorrhois algirus*	AY486911	_	AY487037	AY486935	_	_
217	*Herpetoreas platyceps*	KJ685690	_	_	KJ685640	_	_
218	*Heterodon platirhinos*	GU112412	AY577028	AF402659	JQ598986	JQ599028	_
219	*Hierophis jugularis*	AY486917	AY376769	AY487046	AY486941	_	_
220	*Hierophis spinalis*	AY486924	AY376773	AY487056	AY486948	_	_
221	*Hologerrhum philippinum*	MG458758	_	_	MG458766	_	_
222	*Homoroselaps lacteus*	AY611992	AY611809	FJ404338	AY611901	JQ599029	_
223	*Hoplocephalus bitorquatus*	EU547079	EU547177	EU547031	EU546941	_	_
224	*Hormonotus modestus*	FJ404296	FJ404195	FJ404360	FJ404261	_	_
225	*Hydrelaps darwiniensis*	KC014413	DQ234046	FJ593200	FJ587175	_	_
226	*Hydrodynastes bicinctus*	JQ598935	GQ457742	_	GQ457862	JQ599030	_
227	*Hydromorphus concolor*	GQ895874	_	_	GQ895817	_	_
228	*Hydrophis lamberti*	KC014421	KC014345	KC014496	KC014300	_	_
229	*Hydrops triangularis*	_	GQ457744	_	AF471158	JQ599032	_
230	*Hypnale zara*	KC347463	KC347363	KC347513	KC347402	_	KC347440
231	*Hypsiglena affinis*	_	_	EU363055	_	_	_
232	*Hypsiglena chlorophaea*	KJ486459	KF548588	EU728577	_	_	_
233	*Hypsiglena torquata*	AF471038	_	GQ334584	AF471159	_	_
234	*Hypsirhynchus ferox*	GQ895875	AF158515	FJ416816	GQ895818	_	_
235	*Hypsirhynchus parvifrons*	FJ416740	_	FJ416814	_	_	_
236	*Ialtris dorsalis*	FJ416735	AF158525	FJ416809	_	_	_
237	*Imantodes cenchoa*	GQ334484	GQ457745	GQ334589	GQ457865	EU402643	EU402847

238	*Indotyphlops braminus*	DQ343649	_	_	AF544717	FJ433959	_
239	*Lachesis stenophrys*	AY223603	AF057267	U96026	_	EU402644	_
240	*Lampropeltis getula*	AF337153	_	DQ360485	_	_	_
241	*Lampropeltis ruthveni*	AF337064	_	AY739641	FJ627803	_	_
242	*Lamprophis fuliginosus*	AF471060	AY188079	FJ404365	FJ404270	EU402646	EU402849
243	*Langaha madagascariensis*	_	AY188059	FJ404370	AY187981	_	_
244	*Laticauda colubrina*	EU547040	EU547138	FJ606513	EU366446	FJ433990	_
245	*Laticauda frontalis*	_	FJ587206	FJ593190	FJ587157	_	_
246	*Laticauda guineai*	_	_	FJ606516		_	_
247	*Laticauda laticaudata*	FJ587153	FJ587204	FJ593192	FJ587159	_	_
248	*Laticauda saintgironsi*	_	_	FJ606506		_	_
249	*Laticauda semifasciata*	AB701339	_	_	_	_	_
250	*Leiopython albertisii*	_	EF545053	_	_	_	_
251	*Leptodeira annulata*	GQ334493	GQ457746	GQ334594	AF544690	FJ433998	_
252	*Leptophis depressirostris*	KX660465	_	KX660592	KX660331	_	_
253	*Leptophis diplotropis*	KX660540	KX660271	_	KX660408	_	_
254	*Leptotyphlops conjunctus*	_	GQ469280	_	GQ469069	GQ469184	_
255	*Leptotyphlops humilis*	_	_		_	EU402648	EU402851
256	*Lepturophis albofuscus*	KX660500	KX660231	KX660629	KX660372	_	_
257	*Liasis albertisii*	U69835	_	_	_	_	_
258	*Liasis childreni*	U69837	_	_	_	_	_
259	*Liasis mackloti*	U69839	EF545051	_	AF544726	FJ433970	_
260	*Lichanura trivirgata*	U69844	_	_	AF544687	_	_
261	*Liolaemus darwinii*	KC150152	_	DQ237768	JF272870	KP820851	KP820640
262	*Liopeltis frenatus*	KX660457	KX660184	KX660583	KX660323	_	_
263	*Liophidium chabaudi*	EU394721	FJ404210	FJ404372	FJ387210	_	_
264	*Liophis amarali*	_	GQ457747	_	GQ457867	_	_
265	*Liophis lineatus*	_	_	_	DQ469789	DQ469795	DQ469791
266	*Liophis meridionalis*	_	GQ457750	_	GQ457870	_	_
267	*Liopholidophis sexlineatus*	DQ979985	AY188063	FJ404373	AY187985	_	_
268	*Liotyphlops albirostris*	AF544672	AF366762	_	AF544727	EU402650	EU402853
269	*Loxocemus bicolor*	AY099993	AF544828	_	AY444035	EU402651	_
270	*Lycodonomorphus whytii*	FJ404300	FJ404200	FJ404375	FJ387201	_	_
271	*Lycodryas citrinus*	_	_	HE798413	_	JQ073076	JQ073197
272	*Lystrophis histricus*	_	GQ457753	_	_	_	_
273	*Lytorhynchus diadema*	DQ112076	HQ267794	_	DQ112079	_	_
274	*Macrelaps microlepidotus*	AY611993	AY611810	FJ404340	AY611902	_	_
275	*Macropisthodon rhodomelas*	KX660528	KX660258	JQ687427	KX660399	_	_
276	*Macropisthodon rudis*	JQ687434	_	AY487064	JQ687452	_	_
277	*Macroprotodon cucullatus*	AF471087	AY188065	_	AF471145	_	_
278	*Macrovipera lebetina*	AJ275713	EU624294	DQ897729	_	_	_
279	*Magliophis exiguum*	AF471071	_	FJ416798	AF471117	_	_
280	*Malayopython reticulatus*	U69860	EF545062	_	AF544675	FJ433969	EU624119
281	*Malpolon moilensis*	DQ486333	HQ267802	DQ486309	DQ486157	_	_
282	*Manolepis putnami*	GQ895878	GU018171	_	GQ895820	JQ599035	_
283	*Mastigodryas bifossatus*	_	HM582223	_	HQ157827	_	_
284	*Mastigodryas boddaerti*	GQ895867	HM582224	_	GQ895811	_	_
285	*Mastigodryas melanolomus*	GQ895868	_	_	_	_	_

286	*Mehelya capensis*	HQ207116	_	HQ207158	_	_	_
287	*Melanophidium punctatum*	_	AY701024	_	_	_	_
288	*Micrelaps bicoloratus*	DQ486349	_	_	DQ486173	_	_
289	*Microcephalophis gracilis*	KC014420	KC014341	KC014494	KC014299	_	_
290	*Micropechis ikaheka*	EU547042	FJ587207	GQ397208	EU366449	_	_
291	*Micruroides euryxanthus*	EF137416	Z46483	EF137408	EF137423	_	_
292	*Micrurus fulvius*	U69846	GU045453	GU045453	AY058935	EU402653	EU402856
293	*Micrurus surinamensis*	EF137415	AF544799	JF308709	AF544708	FJ433991	_
294	*Mitophis asbolepis*	GQ469086	GQ469210	_	GQ469059	GQ469174	_
295	*Montivipera wagneri*	_	_	JN870213	_	_	_
296	*Morelia boeleni*	_	EF545047	_	_	_	_
297	*Morelia bredli*	KJ666638	EF545043	_	_	_	_
298	*Morelia carinata*	EF545095	EF545044	_	_	_	_
299	*Morelia viridis*	EF545098	EF545048	_	_	_	_
300	*Myersophis alpestris*	MG458752	_	_	MG458762	_	_
301	*Myriopholis adleri*	_	GQ469246	_	GQ469058	GQ469172	_
302	*Naja haje arabica*	GQ359500	GQ359749	GQ387074	_	_	_
303	*Naja kaouthia*	FR693728	GQ359757	EU624209	AY058938	EU402654	EU402857
304	*Namibiana occidentalis*	_	GQ469251	_	GQ469074	GQ469189	_
305	*Natriciteres olivacea*	AF471058	AF544801	_	AF471146	_	_
306	*Natrix natrix*	AY487749	_	AY487794	AF544697	EU402655	EU402858
307	*Neelaps calonotus*	EU547060	EU547158	EF210841	EU546923	_	_
308	*Nerodia erythrogaster*	AF402912	_	AF420084	JN090137	_	_
309	*Nerodia fasciata*	AF402910	_	AY873705	_	KF258597	_
310	*Ninia atrata*	JQ598937	JQ598882	GQ334659	GQ457874	JQ599037	_
311	*Ninia sebae*	GQ895879	_	_	GQ895821	_	_
312	*Notechis ater*	EU547082	EU547180	EU547034	EU546944		_
313	*Notechis scutatus*	_	_	_	_	EU402656	EU402859
314	*Oligodon arnensis*	KC347464	KC347365	KC347504	KC347404	_	KC347442
315	*Oligodon ningshaanensis*	KJ638715	NC_26083	KJ719252	KJ638717	_	_
316	*Oligodon theobaldi*	_	HM591515	_	_	_	_
317	*Oocatochus rufodorsatus*	KC990020	KC990020	DQ902301	DQ902081	_	_
318	*Ophiophagus hannah*	EU921899	JN687931	EU921899	AY058940	_	_
319	*Ophryacus undulatus*	AY223586	AF057256	AY223633	_	_	_
320	*Opisthotropis cheni*	GQ281779	_	JQ687416	JQ687441	_	_
321	*Oreocryptophis porphyraceus*	KF669255	_	_	DQ902076	_	_
322	*Orthriophis hodgsonii*	DQ902136	_	DQ902318	DQ902096	_	_
323	*Orthriophis taeniurus taeniura*	EF076709	HM439981	DQ902305	DQ902085	_	_
324	*Ovophis chaseni*	AY352760	AY352729	AY352825	_	_	_
325	*Ovophis okinavensis*	AB175670	AB175670	AB175670	_	_	_
326	*Oxybelis aeneus*	AF471056	HM582225	_	AF471148	_	_
327	*Oxyrhabdium leporinum*	AF471029	_	_	DQ112081	_	_
328	*Oxyrhopus fitzingeri*	KX660541	KX660272	_	KX660409	_	_
329	*Oxyrhopus guibei*	JQ598938	JQ627289	_	JQ598989	JQ599038	_
330	*Oxyrhopus trigeminus*	_	KX660274	KX660653	_	_	_
331	*Oxyuranus scutellatus*	EU547051	EU547149	EF210827	EU546916	_	_
332	*Pantherophis guttatus*	AM236349	AM236349	AM236349	DQ902070	_	_
333	*Parahydrophis mertoni*	KC014451	DQ234048	FJ593201	FJ587177	_	_

334	*Parastenophis betsileanus*	GU994802	GU994852	_	GU994827	_	_
335	*Pareas boulengeri*	JF827683	_	_	JF827710	_	
336	*Pareas carinatus*	JF827677	AF544802	JF827653	JF827702	FJ433985	_
337	*Pareas formosensis*	HQ528535	_	HQ528434	KJ642213	_	
338	*Pareas hamptoni*	KX694896	KX694656	_	_	KX694746	_
339	*Pareas iwasakii*	KJ642160	_	_	KJ642209	_	_
340	*Pareas margaritophorus*	AY425805	_	_	KJ642217	_	_
341	*Pareas monticola*	JF827689	_	_	JF827715	_	_
342	*Pareas nuchalis*	_	_	U49311	_	_	_
343	*Pareas stanleyi*	JN230704	_	JN230705	JN230703	_	_
344	*Phalotris lemniscatus*	JQ598941	GQ457756		GQ457877	JQ599039	_
345	*Philodryas chamissonis*	_	_	HM639951	_	_	_
346	*Philothamnus natalensis*	KX660555	KX660290	KX660666	KX660430	_	_
347	*Philothamnus natalensis2*	AY612069	AY611887	_		_	_
348	*Phyllorhynchus decurtatus*	AF471083	_	_	AF544728	FJ434004	_
349	*Pituophis catenifer*	_	_	AF141106	FJ627790	_	_
350	*Pituophis lineaticollis*	_	AF512746	JF308340	FJ627804	_	_
351	*Pituophis melanoleucus*	AF337112	_	_	_	_	_
352	*Plagiopholis styani*	EU496918	_	_	EU496916	_	_
353	*Platyceps karelini*	AY486918	_	_	AY486942	_	_
354	*Platyceps rogersi*	_	AY188082	AY487052	_	_	_
355	*Pliocercus elapoides*	GQ895882	_	_	GQ895824	_	_
356	*Pliocercus euryzona*	KX660440	KX660165	KX660568	KX660304	_	_
357	*Porthidium yucatanicum*	DQ061215	JN870198	DQ061244	_	_	_
358	*Proatheris superciliaris*	AJ275685	EU624296	EU624230	_	_	_
359	*Prosymna janii*	FJ404319	FJ404222	FJ404389	FJ404293	_	_
360	*Protobothrops mangshanensis*	HM567537	AY352726	HM567469	JQ687524	_	_
361	*Psammodynastes pictus*	KX660507	KX660237	_	KX660378	_	_
362	*Psammodynastes pulverulentus*	AF471031	AF544813	_	AF471157	_	_
363	*Psammodynastes sp.*	FJ404318	FJ404221	FJ404383	FJ387218	_	_
364	*Psammophis schokari*	AY612034	AY611852	EF128005	AY611943	_	_
365	*Psammophis sp.*	DQ486444	_	DQ486280	DQ486184	_	_
366	*Pseudalsophis dorsalisial*	JQ598946	JQ598892	_	JQ598994	_	_
367	*Pseudalsophis elegans*	_	_	_	_	JQ599042	_
368	*Pseudaspis cana*	AY612080	AY611898	DQ486319	DQ486167	_	_
369	*Pseudechis australis*	EU547046	EU547144	AY340174	EU546912	_	_
370	*Pseudechis porphyriacus*	EU547047	EU547145	AY340170	EU546913	_	_
371	*Pseudoboa nigra*	JQ598948	GQ457764	_	AF544729	JQ599043	_
372	*Pseudocerastes fieldi*	AJ275716	AJ275769	_	_	_	_
373	*Pseudoeryx plicatilis*	GQ895885	GQ457765	_	GQ895826	_	_
374	*Pseudoficimia frontalis*	GQ895886	_	_	GQ895827	_	_
375	*Pseudoleptodeira latifasciata*	EU728579	EU728579	GQ334661	_	_	_
376	*Pseudonaja modesta*	EU547049	EU547147	DQ098492	EU546915	_	_
377	*Pseudorabdion longiceps*	KX660529	KX660259	_	KX660400	_	_
378	*Pseudotomodon trigonatus*	_	GQ457766	_	GQ457887	_	_
379	*Pseudoxenodon karlschmidti*	AF471080	JF697330	_	AF471102	JQ599045	_
380	*Pseustes poecilonotus*	KX660436	KX660160	KX660563	KX660299	_	_
381	*Pseustes poecilonotus2*	KF669676	_	KF669693	KF669710	_	_

382	*Pseustes poecilonotus3*	KF669671	_	KF669687	KF669705	_	_
383	*Psomophis joberti*	GQ895887	GQ457768	_	GQ895828	JQ599046	_
384	*Ptyas mucosus*	AF471054	KC589121	AY487063	GQ225670	_	_
385	*Ptychophis flavovirgatus*	_	GQ457769	_	GQ457890	_	_
386	*Python bivittatus*	JX401131	KF010492	_	AF435016	XM7433022	_
387	*Pythonodipsas carinata*	_	AY188075	FJ404386	AY187997	_	_
388	*Ramphotyphlops acuticauda*	JQ910543	_	_	_	GU902381	_
389	*Ramphotyphlops australis*	JQ910537	AY442843	_	AF039474	JQ910312	_
390	*Ramphotyphlops braminus*	DQ343649	DQ343649	DQ343649	_	_	AY662612
391	*Regina grahami*	AF402918	_	KF258633	_	KF258599	_
392	*Regina rigida*	AF471052	_	KF258642	AF471120	KF258608	_
393	*Regina septemvittata*	AF402917	_	KF258629	_	KF258595	_
394	*Rena humilis*	AY099991	AB079597	AB079597	AY099979	_	_
395	*Rhabdophis nuchalis*	GQ281786	_	JQ687413	KF800925	_	_
396	*Rhabdophis subminiatus*	GQ281777	AF544805	JQ687411	AF544713	JQ599047	_
397	*Rhadinaea flavilata*	AF471078	_	_	AF471152	_	_
398	*Rhamphiophis oxyrhynchus*	JQ598953	FJ404213	_	AF544710	JQ599049	_
399	*Rhinobothryum lentiginosum*	_	HM582227	_	AF544693	_	_
400	*Rhinocheilus lecontei*	AF337109	_	AF138773	FJ627788	_	_
401	*Rhinoleptus sp.*	_	GQ469242	_	GQ469078	GQ469193	_
402	*Rhinophis drummondhayi*	AF544673	AY701028	_	AF544719	FJ433966	_
403	*Rhinophis erangaviraji*	KC347490	KC347371	KC347503	KC347410	_	KC347448
404	*Rhinoplocephalus bicolor*	EU547068	EU547166	EU547020	EU546930	_	_
405	*Rhinoplocephalus nigrescens*	EU547070	EU547168	EU547022	EU546932	_	_
406	*Rhinotyphlops episcopus*	_	_	_	_	KC848449	_
407	*Rhinotyphlops lalandei*	_	_	_	_	GU902386	_
408	*Sanzinia madagascariensis*	U69866	AY336066	_	EU403580	AY988033	AY988067
409	*Scaphiodontophis annulatus*	GQ927323	_	_	GQ927318	_	_
410	*Scaphiophis albopunctatus*	DQ486345	_	DQ486321	DQ486169	_	_
411	*Senticolis triaspis*	DQ902127	_	AF138775	DQ902086	_	_
412	*Siagonodon septemstriatus*	_	GQ469232	_	GQ469076	GQ469191	_
413	*Sibon annulatus*	KX660443	KX660169	KX660572	KX660308	_	_
414	*Sibon nebulatus*	EU728583	AF544806	GQ334662	AF544736	_	_
415	*Sibon sartorrii*	EF078540	_	EF078588	_	_	_
416	*Sibynomorphus garmani*	_	_	_	GQ457891	_	_
417	*Sibynomorphus mikaniirial*	JQ598954	JQ627298	_	_	JQ599050	_
418	*Sibynomorphus turgidus*	KX660547	KX660279	KX660659	KX660418	_	_
419	*Sibynophis subpunctatus*	KC347471	KC347373	KC347516	KC347411	_	KC347449
420	*Simalia boeleni*	KJ666597	_	_	KF811106	KF811070	_
421	*Simoselaps anomalus*	EU547061	EU547159	EU547014	EU546924	_	KF811168
422	*Sinomicrurus japonicus*	_	_	AY058971	AY058926	_	_
423	*Sinonatrix annularis*	JQ687431	HM439988	JQ687424	AF544712	_	_
424	*Siphlophis cervinus*	GQ895888	AF158536	_	GQ895829	_	_
425	*Sistrurus catenatus*	AY223610	AF259119	_	KF410311	_	_
426	*Sordellina punctata*	JQ598956	JQ598903	_	JQ599000	JQ599052	_
427	*Spilotes pullatus*	AF471041	HM582228	KF669677	AF471110	_	_
428	*Spilotes sulphureus*	KX660545	KX660276	KX660656	KX660415	_	_
429	*Stenophis betsileanus*	_	_	FJ404387	_	_	_

430	*Stenophis citrinus*	AY612047	AY611865	KF258627	AY611956	_	_
431	*Stenorrhina freminvillei*	GQ895889	_	_	GQ895830	_	_
432	*Stoliczkia borneensis*	_	AF544808	_	AF544721	FJ433982	_
433	*Storeria dekayi*	AF471050	JQ598904	_	AF471154	KF258593	_
434	*Suta fasciata*	EU547064	EU547162	EU547016	EU546927	_	_
435	*Suta monachus*	EU547067	EU547165	EU547019	EU546929	_	_
436	*Suta spectabilis*	EU547065	EU547163	EU547017	EU546928	_	_
437	*Suta suta*	EU547066	EU547164	EU547018	EU366452	_	_
438	*Sympholis lippiens*	GQ895890	_	_	GQ895831	_	_
439	*Tachymenis peruviana*	_	GQ457774	_	GQ457895	JQ599054	_
440	*Taeniophallus affinis*	JQ598957	GQ457733	_	GQ457853	JQ599055	_
441	*Tantalophis discolor*	EF078541	_	EF078589	_	_	_
442	*Tantilla melanocephala*	_	AF158491	_	_	_	_
443	*Tantilla relicta*	AF471045	_	_	AF471107	_	_
444	*Telescopus beetzi*	KX660551	KX660287	KX660663	KX660426	_	_
445	*Telescopus fallax*	AF471043	AY188078	_	AF471108	_	_
446	*Thamnodynastes hypoconia*	KX660523	KX660253	KX660643	KX660394	_	_
447	*Thamnodynastes pallidus*	GQ895891	GU018166	_	GQ895832	_	_
448	*Thamnodynastes strigatus*	_	KX660281	_	KX660420	_	_
449	*Thamnophis butleri*	AF402923	_	KF258628	_	KF258594	_
450	*Thamnophis godmani*	_	_	AF420138	AF471165	_	_
451	*Thamnophis sirtalis*	_	_	_	_	_	XM014075835
452	*Thelotornis capensis*	AF471042	_	_	AF471109	_	_
453	*Thelotornis kirtlandii*	KX660466	KX660193	KX660593	KX660332	_	_
454	*Thermophis zhaoermii*	GQ166168	GQ166168	EU864150	KF514882	_	_
455	*Thrasops flavigularis*	_	KX660286	KX660662	KX660425	_	_
456	*Thrasops jacksonii*	AF471044	_	_	DQ112084	_	_
457	*Tomodon dorsatus*	GQ895892	GQ457777	_	GQ895833	JQ599059	_
458	*Toxicocalamus loriae*	GQ397170	GQ397235	GQ397211	GQ397225	_	_
459	*Toxicocalamus preussi*	EU547043	EU547141	EU547001	EU546909	_	_
460	*Toxicodryas blandingii*	KX660549	KX660283	_	KX660422	_	_
461	*Toxicodryas pulverulenta*	KX660460	KX660187	_	AF471118.2	_	_
462	*Toxicodryas pulverulenta*	AF471047	_	KX660586	_	_	_
463	*Trachischium monticola*	JQ687435	_	JQ687428	JQ687453	_	_
464	*Trimeresurus albolabris*	KF311102	KF311102	AY352837	_	_	_
465	*Trimeresurus nebularis*	KX660506	KX660236	KX660634	KX660377	_	_
466	*Trimeresurus trigonocephalus*	KC347479	KC347374	AY059597	KC347412	_	_
467	*Trimorphodon biscutatus*	GQ927324	_	DQ497506	GQ927319	EU402662	EU402864
468	*Tropidechis carinatus*	EU547081	EU547179	EU547033	EU546943	_	_
469	*Tropidoclonion lineatum*	AF402931	_	KF258638	_	KF258604	_
470	*Tropidodipsas fischeri*	KX660553	KX660289	KX660664	KX660428	_	_
471	*Tropidodryas striaticeps*	AF236811	GQ457778	_	_	JQ599060	_
472	*Tropidolaemus subannulatus*	KX660525	KX660255	KX660644	KX660396	_	_
473	*Tropidolaemus wagleri*	GQ428472	AY352727	AY352822	_	_	_
474	*Tropidophis feicki*	KF811124	AF512733	_	KF811110	KF811074	_
475	*Tropidophis wrighti*	_	Z46476	_	_	_	_
476	*Tropidurus plica*	EF616028	EF615664	EF616320	EF615737	JF806028	JF806213
477	*Typhlops andasibensis*	_	_	_	_	GU902453	JQ073249

478	*Typhlops diardii*	_	_	_	_	KF992877	_
479	*Typhlops jamaicensis*	KF993259	AF366764	_	AF544733	EU402664	EU402866
480	*Typhlops luzonensis*	_	AF366763	_	_	GU902393	_
481	*Typhlops mirus*	AM236345	AM236345	AM236345	_	GU902394	_
482	*Typhlops reticulatus*	EU747730	EU747730	EU747730	_	GU902396	_
483	*Typhlops ruber*	_	AF512728	_	_	_	_
484	*Typhlops sulcatus*	KF993280	AF366771	_	_	GU902441	_
485	*Typhlops vermicularis*	JQ910544	_	_	_	GU902397	_
486	*Ungaliophis continentalis*	U69870	AF544833	_	AF544724	EU402665	EU402867
487	*Ungaliophis panamensis*	KX660445	KX660171	KX660574	KX660310	_	_
488	*Uromacer catesbyi*	FJ416714	AF158523	FJ416788	_	_	_
489	*Varanus salvator*	EU621812	EU621807	AY033776	AF435017	EU402618	EU402828
490	*Vipera ammodytes*	DQ186504	EU624297	EU624232	_	_	_
491	*Vipera wagneri*	AJ275725	AJ275778	_	_	_	_
492	*Virginia striatula*	KF258657	_	KF258640	_	KF258606	_
493	*Virginia valeriae*	KF258656	_	KF258639	KP765645	KF258605	_
494	*Walterinnesia aegyptia*	_	HQ267785	AY058988	AY058943	_	_
495	*Xylophis captaini*	xxx	xxx	xxx	xxx	xxx	_
496	*Xylophis perroteti*	_	xxx	_	xxx	xxx	xxx
497	*Xylophis stenorhynchus*	_	xxx	_	xxx	xxx	_
498	*Xenochrophis asperrimus*	_	_	_	_	_	KC347451
499	*Xenochrophis flavipunctatus*	_	AF544809	_	AF544714	FJ434001	_
500	*Xenodermus javanicus*	_	AF544810	U49320	AF544711	EU402667	EU402869
501	*Xenodon histricus*	JQ598962	_	_	_	JQ599061	_
502	*Xenopeltis unicolor*	AB179620	AB179620	AB179620	AF544689	EU402668	DQ465564
503	*Xenophidion schaeferi*	AY574279	_	_	_	_	_
504	*Xenopholis scalaris*	GQ895897	GU018164	_	GQ895837	_	_
505	*Xenotyphlops grandidieri*	KF770844	_	_	_	GU902457	_
506	*Xenoxybelis argenteus*	JQ598944	GQ457780	_	GQ457899	JQ599040	_
507	*Zamenis hohenackeri*	DQ902137	_	DQ902320	DQ902098	_	_

Table S2. Partitions and models of sequence evolution used in the Maximum Likelihood (ML) phylogenetic analyses.

Subset	Best Model	# sites	Partition names
1	GTR+I+G	582	*16s*
2	K80+I+G	528	*bdnf* 1st, *rag1* 2nd
3	K80+I	233	*bdnf* 2nd
4	K80+I+G	233	*bdnf* 3rd
5	GTR+I+G	233	*nd4* 1st
6	GTR+I+G	600	*nd4* 2nd, *cytb* 2nd
7	GTR+G	233	*nd4* 3rd
8	HKY+I+G	690	*rag1* 1st, *cmos* 2nd, *cmos* 1st
9	GTR+G	491	*cmos* 3rd, *rag1* 3rd
10	GTR+I+G	367	*cytb* 1st
11	GTR+G	367	*cytb* 3rd

Table S3. Partitions and models of sequence evolution used in the Bayesian (BEAST) phylogenetic analyses.

Subset	Best Model	# sites	Partition names
1	GTR+I+G	529	*16s*
2	K80+G	233	*bdnf* 1st
3	HKY+I+G	759	*bdnf* 3rd, *bdnf* 2nd, *rag1* 2nd
4	GTR+I+G	600	*cytb* 1st, *nd4* 1st
5	GTR+I+G	600	*nd4* 2nd, *cytb* 2nd
6	GTR+I+G	600	*cytb* 3rd, *nd4* 3rd
7	HKY+G	690	*cmos* 1st, *cmos* 2nd, *rag1* 1st
8	HKY+G	491	*rag1* 3rd, *cmos* 3rd

Table S4. Node calibration settings used in the BEAST analysis.

S.no.	Node calibrations	Offset	mean	5%	95%
1	Oldest divergence within crown Alethinophidia	93.9	2	94.1	100.2
2	Oldest divergence between non-xenodermid colubroids and their closest living relative	50.5	6	51.2	69.35
3	Divergence between Boinae and its sister taxon	58.0	2	58.2	64.3
4	Divergence between Viperinae and Crotalinae	20.0	1	20.1	23.1
5	Oldest divergence within elapids	17.0	10	18.2	48.4

Table S5. Pairwise uncorrected genetic distances of bdnf gene sequences for 92 taxa. Values in bold are within family/subfamily genetic distances.

	Family (subfamily)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Colubridae (Calamariinae)																					
2	Colubridae (Dipsadinae)	0.01–0.02	**0.01–0.02**																			
3	Colubridae (Pseudoxenodontinae)	0.02–0.04	0.01–0.03	**0–0.04**																		
4	Colubridae (Natricinae)	0.02	0.01–0.02	0.01–0.03																		
5	Colubridae (Colubrinae)	0.02–0.04	0.01–0.03	0.01–0.05	0.02–0.03	**0–0.03**																
6	Colubridae (Grayiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03																
7	Elapidae	0.02–0.03	0.01–0.02	0.02–0.04	0.02–0.03	0.02–0.03	0.02–0.03	**0–0.02**														
8	Elapidae (Hydrophiinae)	0.02	0.01	0.01–0.03	0.02	0.01–0.03	0.02	0.01														
9	Elapidae (Laticaudinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.01–0.02	0													
10	Homalopsidae	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.02	0.02	0.02												
11	Lamprophiidae (Lamprophiinae)	0.03	0.02–0.03	0.03–0.05	0.03	0.03–0.04	0.03	0.03	0.03	0.03	0.03											
12	Lamprophiidae (Aparallactinae)	0.02	0.01–0.02	0.01–0.04	0.02	0.01–0.03	0.01–0.02	0.01–0.02	0.01	0.01–0.02	0.02	0.02	**0.01**									
13	Lamprophiidae (Atractaspidinae)	0.02	0.01–0.02	0.01–0.03	0.02	0.02–0.03	0.02	0.01–0.02	0.01	0.02	0.02	0.03	0.01–0.02	**0.01**								
14	Lamprophiidae (Psammophiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.01–0.02	0.01	0.02	0.02	0.03	0.02	0.02								
15	Lamprophiidae (Pseudoxyrhophiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.02	0.01	0.01–0.02	0.02	0.02–0.03	0.01–0.02	0.02	0.02	**0.02**						
16	Pareidae (Pareinae)	0.03–0.04	0.03–0.04	0.04–0.06	0.04	0.03–0.06	0.04–0.05	0.04–0.05	0.04	0.04	0.04–0.05	0.05–0.06	0.04	0.04	0.04	0.04	**0.02**					
17	Pareidae (Xylophiinae subfam. nov.)	0.02	0.02–0.03	0.03–0.04	0.02	0.03–0.04	0.03	0.03–0.04	0.03	0.02	0.03	0.04	0.03	0.03	0.03	0.02–0.03	0.02–0.03	**0.01**				
18	Viperidae (Azemiopinae)	0.02	0.01–0.02	0.01–0.03	0.02	0.02–0.03	0.02	0.02	0.01	0.02	0.02	0.03	0.01–0.02	0.02	0.02	0.01–0.02	0.03–0.04	0.02				
19	Viperidae (Crotalinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.03–0.04	0.02	0–0.01	**0–0.01**		
20	Viperidae (Viperinae)	0.02–0.03	0.02	0.02–0.04	0.02	0.02–0.04	0.03	0.02–0.03	0.02	0.02	0.02–0.03	0.04	0.02–0.03	0.02	0.02–0.03	0.02–0.03	0.03–0.04	0.03	0.01	0.01–0.02	**0.01**	
21	Xenodermidae	0.04–0.05	0.03–0.05	0.04–0.08	0.04–0.05	0.03–0.07	0.04–0.05	0.04–0.06	0.04–0.05	0.03–0.05	0.04–0.05	0.05–0.06	0.04–0.05	0.04–0.05	0.04–0.05	0.04–0.05	0.05–0.06	0.04–0.05	0.03–0.04	0.03–0.04	0.03–0.05	**0.03**

Table S6. Pairwise uncorrected genetic distances of cmos gene sequences for 308 taxa. Values in bold are within family/subfamily genetic distances.

	Family(subfamily)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	Colubridae(Ahaetullinae)	**0.01–0.03**																										
2	Colubridae(Calamariinae)	0.03–0.04	**0.03**																									
3	Colubridae(Colubrinae)	0.02–0.05	0.02–0.06	**0–0.05**																								
4	Colubridae(Dipsadinae)	0.02–0.06	0.02–0.06	0.01–0.07	**0–0.06**																							
5	Colubridae(Grayiinae)	0.03–0.04	0.03–0.04	0.03–0.05	0.03–0.06	**0.04**																						
6	Colubridae(Natricinae)	0.02–0.06	0.02–0.06	0.01–0.07	0–0.08	0.02–0.06	**0–0.07**																					
7	Colubridae(Pseudoxenodontinae)	0.03–0.04	0.03–0.04	0.03–0.05	0.03–0.06	0.04	0.03–0.06	**0.01–0.05**																				
8	Colubridae(Sibynophiinae)	0.03–0.05	0.02–0.05	0–0.07	0.02–0.07	0.03–0.04	0.03–0.06	0.04–0.06	**0.04–0.05**																			
9	Elapidae	0.03–0.05	0.03–0.06	0.02–0.07	0.02–0.07	0.03–0.05	0.02–0.07	0.03–0.06	0.04–0.05	**0–0.06**																		
10	Elapidae(Hydrophiinae)	0.03–0.08	0.03–0.09	0.02–0.1	0.02–0.1	0.02–0.09	0.02–0.1	0.03–0.09	0.03–0.09	0–0.09	**0–0.09**																	
11	Elapidae(Laticaudinae)	0.04–0.06	0.04–0.06	0.04–0.06	0.04–0.07	0.04–0.05	0.04–0.08	0.05	0.05–0.06	0.01–0.06	0.01–0.09	**0–0.02**																
12	Homalopsidae	0.04–0.05	0.04–0.06	0.04–0.07	0.03–0.07	0.05	0.03–0.07	0.05–0.06	0.05–0.06	0.04–0.06	0.04–0.09	0.04–0.06	**0.02–0.06**															
13	Lamprophiidae(Aparallactinae)	0.03–0.05	0.03–0.05	0.03–0.07	0.03–0.07	0.04–0.06	0.03–0.07	0.04–0.06	0.04–0.05	0.02–0.06	0.01–0.09	0.03–0.04	0.03–0.06	**0.01–0.05**														
14	Lamprophiidae(Atractaspidinae)	0.04–0.06	0.05–0.06	0.04–0.07	0.04–0.07	0.05–0.06	0.04–0.07	0.05–0.06	0.05–0.06	0.03–0.06	0.02–0.09	0.04–0.05	0.04–0.06	0.03–0.06	**0.02–0.03**													
15	Lamprophiidae(Colubroidea)	0.03–0.05	0.03–0.05	0.03–0.06	0.03–0.07	0.05	0.04–0.08	0.04–0.07	0.04–0.05	0.02–0.06	0.02–0.09	0.03–0.05	0.03–0.06	0.03–0.05	0.02–0.04	**0–0.04**												
16	Lamprophiidae(Cyclocorinae)	0.02–0.05	0.03–0.05	0.02–0.06	0.01–0.06	0.03–0.05	0.02–0.06	0.04–0.06	0.03–0.05	0.02–0.05	0.01–0.08	0.02–0.05	0.03–0.04	0.03–0.05	0.02–0.04	0.02–0.05	**0.01–0.04**											
17	Lamprophiidae(incertaesedis)	0.04–0.06	0.04–0.06	0.03–0.07	0.03–0.07	0.05–0.06	0.04–0.07	0.05–0.06	0.05–0.06	0.03–0.07	0.02–0.09	0.03–0.04	0.04–0.06	0.04–0.05	0.03–0.04	0.03–0.04	0.03–0.04	**0.03–0.04**										
18	Lamprophiidae(Lamprophiinae)	0.04–0.06	0.03–0.07	0.03–0.08	0.02–0.07	0.04–0.05	0.03–0.08	0.04–0.07	0.04–0.06	0.02–0.06	0.03–0.09	0.03–0.06	0.04–0.07	0.03–0.06	0.02–0.05	0.03–0.06	0.03–0.05	0.04–0.05	**0.01–0.05**									
19	Lamprophiidae(Prosymninae)	0.03–0.04	0.03–0.04	0.02–0.05	0.02–0.05	0.03	0.02–0.06	0.04–0.05	0.04	0.01–0.04	0.01–0.07	0.02–0.03	0.03–0.05	0.02–0.04	0.02–0.03	0.02–0.04	0.02–0.03	0.03–0.04	0.03–0.04	**0.03**								
20	Lamprophiidae(Psammophiinae)	0.02–0.06	0.03–0.06	0.02–0.07	0.02–0.08	0.04–0.06	0.02–0.08	0.03–0.06	0.03–0.06	0.01–0.06	0–0.1	0.02–0.05	0.02–0.06	0.02–0.06	0.01–0.04	0.01–0.05	0.01–0.04	0.02–0.05	0.01–0.05	0.02–0.04	**0–0.04**							
21	Lamprophiidae(Pseudoxyrhophiinae)	0.03–0.05	0.04–0.06	0.03–0.07	0.03–0.07	0.04–0.06	0.03–0.08	0.04–0.07	0.04–0.06	0.02–0.06	0.02–0.08	0.03–0.05	0.03–0.06	0.03–0.05	0.02–0.04	0.03–0.04	0.02–0.04	0.03–0.04	0.03–0.05	0.03–0.04	0.01–0.04	**0–0.04**						
22	Pareatidae	0.05–0.09	0.05–0.09	0.05–0.1	0.04–0.11	0.05–0.09	0.05–0.11	0.06–0.1	0.06–0.09	0.05–0.1	0.04–0.11	0.06–0.1	0.06–0.09	0.06–0.1	0.05–0.09	0.05–0.09	0.04–0.08	0.05–0.09	0.06–0.1	0.06–0.09	0.04–0.1	0.05–0.1	**0.01–0.09**					
23	Pareatidae(XY)	0.05–0.07	0.05–0.08	0.04–0.08	0.04–0.1	0.05–0.06	0.05–0.09	0.06–0.08	0.04–0.07	0.05–0.1	0.03–0.11	0.06–0.07	0.05–0.07	0.05–0.07	0.05–0.07	0.05–0.07	0.04–0.07	0.05–0.09	0.06–0.09	0.06	0.05–0.1	0.05–0.1	0.03–0.1	**0.03–0.07**				
24	Viperidae(Azemiopinae)	0.04–0.05	0.05–0.06	0.03–0.06	0.02–0.06	0.04	0.03–0.07	0.05–0.06	0.04–0.05	0.04–0.06	0.03–0.06	0.05	0.04–0.05	0.04–0.05	0.04–0.05	0.04–0.06	0.03–0.05	0.05–0.06	0.05–0.07	0.05	0.04–0.05	0.04–0.05	0.05–0.08	0.04–0.05	**0.05**			
25	Viperidae(Crotalinae)	0.03–0.06	0.02–0.07	0.01–0.07	0.02–0.08	0.03–0.05	0.02–0.07	0.04–0.06	0.02–0.07	0.03–0.07	0.02–0.08	0.04–0.06	0.05–0.06	0.04–0.07	0.04–0.07	0.04–0.07	0.03–0.06	0.04–0.06	0.04–0.07	0.04–0.07	0.03–0.07	0.04–0.07	0.04–0.08	0.05–0.06	0.04–0.07	**0.01–0.06**		
26	Viperidae(Viperinae)	0.04–0.06	0.04–0.07	0.03–0.07	0.02–0.08	0.04–0.06	0.03–0.08	0.05–0.08	0.04–0.07	0.04–0.07	0.03–0.08	0.04–0.07	0.04–0.07	0.04–0.07	0.04–0.07	0.04–0.08	0.03–0.06	0.04–0.07	0.05–0.08	0.05–0.07	0.03–0.07	0.04–0.06	0.05–0.09	0.04–0.06	0.05–0.07	0.01–0.06	**0.01–0.04**	
27	Xenodermidae	0.08–0.1	0.09–0.11	0.08–0.11	0.08–0.11	0.09–0.1	0.09–0.12	0.1–0.11	0.09–0.1	0.09–0.11	0.08–0.11	0.09–0.11	0.1–0.11	0.09–0.1	0.08–0.09	0.09–0.11	0.08–0.1	0.1	0.08–0.11	0.09–0.1	0.08–0.1	0.09–0.1	0.09–0.13	0.09–0.1	0.12–0.13	0.08–0.1	0.08–0.09	**0.02–0.09**

Table S7. Pairwise Kimura 2–parameter genetic distances of bdnf gene sequences for 92 taxa. Values in bold are within family/subfamily genetic distances.

	Family (subfamily)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Colubridae (Calamariinae)																					
2	Colubridae (Dipsadinae)	0.01–0.02	**0.01–0.02**																			
3	Colubridae (Pseudoxenodontinae)	0.02–0.04	0.01–0.03	0–0.04																		
4	Colubridae (Natricinae)	0.02	0.01–0.02	0.01–0.03																		
5	Colubridae (Colubrinae)	0.02–0.04	0.01–0.03	0.01–0.05	0.02–0.03	**0–0.03**																
6	Colubridae (Grayiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03																
7	Elapidae	0.02–0.03	0.01–0.02	0.02–0.05	0.02–0.03	0.02–0.04	0.02–0.03	**0–0.02**														
8	Elapidae (Hydrophiinae)	0.02	0.01	0.01–0.03	0.02	0.01–0.03	0.02	0.01														
9	Elapidae (Laticaudinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.01–0.02	0.01													
10	Homalopsidae	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.03	0.02	0.02	0.02												
11	Lamprophiidae (Lamprophiinae)	0.03	0.02–0.03	0.03–0.05	0.03	0.03–0.04	0.03	0.03	0.03	0.03	0.03											
12	Lamprophiidae (Aparallactinae)	0.02	0.01–0.02	0.01–0.04	0.02	0.01–0.03	0.01–0.02	0.01–0.02	0.01	0.01–0.02	0.02	0.02	**0.01**									
13	Lamprophiidae (Atractaspidinae)	0.02	0.01–0.02	0.01–0.04	0.02	0.02–0.03	0.02	0.01–0.02	0.01	0.02	0.02	0.03	0.01–0.02	**0.01**								
14	Lamprophiidae (Psammophiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.04	0.02	0.01–0.02	0.01	0.02	0.02	0.03	0.02	0.02								
15	Lamprophiidae (Pseudoxyrhophiinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.03	0.02	0.02	0.01	0.01–0.02	0.02	0.02–0.03	0.01–0.02	0.02	0.02	**0.01–0.02**						
16	Pareidae (Pareinae)	0.03–0.04	0.03–0.05	0.04–0.07	0.04	0.04–0.06	0.04–0.05	0.04–0.05	0.04	0.04	0.04–0.05	0.05–0.06	0.04–0.05	0.04–0.05	0.04–0.05	0.04–0.05	**0.02**					
17	Pareidae (Xylophiinae subfam. nov.)	0.02	0.02–0.03	0.03–0.05	0.02	0.03–0.05	0.03	0.03–0.04	0.03	0.02	0.03	0.04	0.03	0.03	0.03	0.03	0.02–0.03					
18	Viperidae (Azemiopinae)	0.02	0.01–0.02	0.01–0.04	0.02	0.02–0.03	0.02	0.02	0.01	0.02	0.02	0.03	0.01–0.02	0.02	0.02	0.01–0.02	0.03–0.04	0.02				
19	Viperidae (Crotalinae)	0.02	0.01–0.02	0.02–0.04	0.02	0.02–0.04	0.02–0.03	0.02–0.03	0.02	0.02	0.02	0.03–0.04	0.02	0.02	0.02–0.03	0.02	0.03–0.04	0.02	0–0.01	**0–0.01**		
20	Viperidae (Viperinae)	0.03	0.02	0.02–0.04	0.02	0.02–0.04	0.03	0.02–0.03	0.02	0.02	0.02–0.03	0.04	0.02–0.03	0.02	0.03	0.02–0.03	0.03–0.05	0.03	0.01	0.01–0.02	**0.01**	
21	Xenodermidae	0.04–0.06	0.03–0.05	0.04–0.08	0.04–0.06	0.03–0.07	0.04–0.06	0.04–0.06	0.04–0.05	0.04–0.05	0.04–0.05	0.05–0.07	0.04–0.06	0.04–0.06	0.04–0.05	0.04–0.06	0.05–0.07	0.04–0.05	0.03–0.04	0.03–0.05	0.04–0.05	**0.03**

Table S8. Pairwise Kimura 2–parameter genetic distances of cmos gene sequences for 92 taxa. Values in bold are within family/subfamily genetic distances.

	Family(subfamily)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	Colubridae(Ahaetullinae)	**0.01–0.03**																										
2	Colubridae(Calamariinae)	0.03–0.04	**0.03**																									
3	Colubridae(Colubrinae)	0.02–0.05	0.02–0.06	**0–0.05**																								
4	Colubridae(Dipsadinae)	0.02–0.06	0.02–0.06	0.01–0.07	**0–0.07**																							
5	Colubridae(Grayiinae)	0.03–0.04	0.03–0.05	0.03–0.06	0.03–0.06	**0.04**																						
6	Colubridae(Natricinae)	0.02–0.06	0.02–0.07	0.01–0.07	0–0.08	0.02–0.06	**0–0.07**																					
7	Colubridae(Pseudoxenodontina	0.03–0.04	0.03–0.05	0.03–0.06	0.03–0.06	0.04	0.03–0.07	**0.01–0.06**																				
8	Colubridae(Sibynophiinae)	0.03–0.05	0.02–0.05	0–0.08	0.02–0.07	0.03–0.04	0.03–0.07	0.04–0.06	**0.04–0.05**																			
9	Elapidae	0.03–0.06	0.03–0.06	0.02–0.07	0.02–0.08	0.03–0.06	0.02–0.08	0.04–0.06	0.04–0.06	**0–0.07**																		
10	Elapidae(Hydrophiinae)	0.03–0.09	0.03–0.09	0.02–0.1	0.02–0.11	0.02–0.09	0.02–0.11	0.03–0.09	0.03–0.09	0–0.1	**0–0.1**																	
11	Elapidae(Laticaudinae)	0.04–0.06	0.04–0.06	0.04–0.07	0.04–0.07	0.04–0.05	0.04–0.08	0.05–0.06	0.05–0.06	0.01–0.07	0.01–0.1	**0–0.02**																
12	Homalopsidae	0.04–0.06	0.04–0.06	0.04–0.07	0.03–0.07	0.05	0.04–0.08	0.05–0.06	0.05–0.06	0.04–0.06	0.04–0.09	0.05–0.06	**0.02–0.06**															
13	Lamprophiidae(Aparallactinae)	0.03–0.06	0.03–0.06	0.03–0.07	0.03–0.08	0.04–0.06	0.03–0.07	0.04–0.06	0.04–0.05	0.02–0.07	0.01–0.09	0.03–0.04	0.03–0.06	**0.01–0.06**														
14	Lamprophiidae(Atractaspidinae)	0.05–0.06	0.05–0.07	0.04–0.07	0.04–0.08	0.05–0.06	0.04–0.08	0.05–0.06	0.05–0.06	0.03–0.07	0.02–0.1	0.04–0.05	0.04–0.07	0.03–0.06	**0.02**													
15	Lamprophiidae(Colubroidea)	0.03–0.06	0.03–0.06	0.03–0.07	0.03–0.07	0.05	0.04–0.09	0.05–0.08	0.04–0.06	0.02–0.06	0.02–0.1	0.03–0.06	0.03–0.06	0.03–0.06	0.02–0.04	**0–0.04**												
16	Lamprophiidae(Cyclocorinae)	0.02–0.05	0.03–0.05	0.02–0.06	0.01–0.07	0.03–0.05	0.02–0.07	0.04–0.06	0.04–0.05	0.02–0.05	0.01–0.08	0.02–0.05	0.03–0.05	0.03–0.05	0.02–0.04	0.02–0.05	**0.01–0.04**											
17	Lamprophiidae(incertaesedis)	0.04–0.06	0.04–0.07	0.04–0.07	0.04–0.08	0.05–0.06	0.04–0.08	0.05–0.06	0.05–0.06	0.03–0.08	0.02–0.09	0.03–0.04	0.04–0.07	0.04–0.06	0.03–0.05	0.03–0.04	0.03–0.05	**0.04–0.05**										
18	Lamprophiidae(Lamprophiinae)	0.04–0.06	0.04–0.07	0.03–0.08	0.03–0.08	0.04–0.06	0.03–0.09	0.05–0.08	0.04–0.06	0.02–0.06	0.03–0.09	0.03–0.06	0.04–0.07	0.03–0.07	0.02–0.05	0.03–0.06	0.03–0.06	0.04–0.06	**0.01–0.05**									
19	Lamprophiidae(Prosymninae)	0.03–0.04	0.03–0.05	0.02–0.06	0.02–0.05	0.03	0.02–0.06	0.04–0.05	0.04	0.01–0.04	0.01–0.07	0.02–0.03	0.03–0.05	0.02–0.05	0.02–0.03	0.02–0.04	0.02–0.03	0.03–0.04	0.03–0.04	**0.03**								
20	Lamprophiidae(Psammophiinae	0.02–0.06	0.03–0.07	0.02–0.07	0.02–0.08	0.04–0.06	0.02–0.08	0.04–0.07	0.03–0.06	0.01–0.07	0–0.1	0.02–0.05	0.03–0.06	0.02–0.06	0.01–0.04	0.01–0.05	0.01–0.04	0.02–0.05	0.01–0.05	0.02–0.04	**0–0.04**							
21	Lamprophiidae(Pseudoxyrhoph	0.03–0.05	0.04–0.06	0.03–0.07	0.03–0.07	0.04–0.06	0.03–0.09	0.05–0.07	0.04–0.06	0.02–0.06	0.02–0.09	0.03–0.05	0.03–0.06	0.03–0.05	0.02–0.04	0.03–0.04	0.02–0.04	0.03–0.04	0.03–0.05	0.03–0.04	0.01–0.04	**0–0.04**						
22	Pareatidae	0.05–0.09	0.05–0.1	0.05–0.11	0.05–0.12	0.06–0.1	0.05–0.12	0.06–0.11	0.06–0.1	0.05–0.11	0.04–0.12	0.06–0.11	0.06–0.1	0.06–0.1	0.05–0.1	0.05–0.1	0.04–0.09	0.06–0.09	0.06–0.11	0.06–0.09	0.05–0.1	0.05–0.1	**0.01–0.1**					
23	Pareatidae(XY)	0.05–0.07	0.05–0.09	0.04–0.09	0.04–0.11	0.06	0.05–0.09	0.06–0.09	0.04–0.07	0.05–0.11	0.04–0.12	0.06–0.08	0.05–0.08	0.06–0.08	0.06–0.07	0.05–0.07	0.04–0.08	0.05–0.1	0.06–0.1	0.06–0.07	0.05–0.1	0.05–0.1	0.04–0.11	**0.03–0.08**				
24	Viperidae(Azemiopinae)	0.05	0.05–0.06	0.03–0.06	0.02–0.07	0.04	0.04–0.07	0.06	0.04–0.05	0.04–0.07	0.03–0.07	0.05–0.06	0.04–0.06	0.05	0.04–0.05	0.04–0.07	0.03–0.05	0.05–0.06	0.05–0.07	0.06	0.04–0.06	0.04–0.06	0.05–0.08	0.04–0.06	**0.05**			
25	Viperidae(Crotalinae)	0.03–0.07	0.02–0.07	0.01–0.07	0.02–0.08	0.03–0.06	0.02–0.08	0.04–0.06	0.02–0.07	0.03–0.08	0.02–0.09	0.04–0.07	0.05–0.07	0.05–0.08	0.04–0.07	0.04–0.07	0.03–0.06	0.04–0.07	0.04–0.08	0.05–0.07	0.03–0.08	0.04–0.07	0.05–0.09	0.05–0.06	0.04–0.07	**0.01–0.06**		
26	Viperidae(Viperinae)	0.04–0.07	0.05–0.08	0.03–0.08	0.02–0.08	0.04–0.06	0.04–0.09	0.05–0.08	0.04–0.07	0.04–0.07	0.03–0.08	0.05–0.07	0.04–0.07	0.04–0.07	0.04–0.07	0.04–0.08	0.03–0.07	0.04–0.08	0.05–0.09	0.05–0.07	0.04–0.07	0.04–0.07	0.05–0.09	0.04–0.07	0.05–0.08	0.01–0.06	**0.01–0.04**	
27	Xenodermidae	0.09–0.11	0.1–0.11	0.09–0.12	0.09–0.13	0.1–0.11	0.09–0.14	0.11–0.12	0.1–0.11	0.1–0.12	0.09–0.11	0.1–0.11	0.1–0.12	0.1–0.11	0.09–0.1	0.1–0.11	0.09–0.11	0.1–0.11	0.09–0.12	0.1	0.08–0.1	0.09–0.11	0.1–0.14	0.09–0.11	0.14–0.15	0.09–0.1	0.09–0.1	**0.03–0.09**